

# Annual Report 2018

## INSTITUTO DE FÍSICA DE CANTABRIA



Hubble Telescope discovers the most distant star  
Nature Astronomy. DOI: 10.1038/s41550-018-0430-3



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Prof. Teresa Rodrigo Anoro  
IFCA Director



**1. WELCOME** This document presents the 2018 scientific report of Cantabria's Institute of Physics (Instituto de Física de Cantabria, IFCA). IFCA is a multidisciplinary research center with focus on the study of the fundamental structure of the Universe, from the smallest objects (Particle Physics) to the largest structures (Cosmology, Astrophysics and Astronomy). We also investigate nonlinear phenomena and collective behavior of physical systems. In addition to carrying out cutting edge basic research, we address societal global challenges such as the treatment of Big-Data, developments on Artificial Intelligence, Climate and Climate change, and participate in international initiatives to provide computational support to the Open Science paradigm.

A fundamental pillar of our research is the collaboration with the largest scientific agencies and laboratories (CERN, ESA, ESO, etc.) as well as the participation in the most relevant international projects in our areas of interest (CORDEX, IPCC, EOSC-Hub, etc.). The level of excellence of our activity in different fronts makes IFCA an internationally recognized research center. In November 2018 we received the accreditation as a Unit of Excellence Maria de Maeztu, issued by the Spanish Ministry of Science, Innovation and Universities. Besides the scientific merit of the award, this recognition provides extra funds, and the possibility to apply to specific calls to attract young talent. This is an excellent opportunity that surely will foster the research capability of the institute. The aim of our Maria de Maeztu project, also displayed in our Plan of Excellence 2017-2020, is to reinforce the current research lines, and to enlarge our scientific output by exploiting and promoting synergies among the different research lines, thus taking full advantage of the unique composition of our center.

During 2018 IFCA maintained high standards in its activity. We participated in 230 papers published in top international specialized journals, 90% of the articles corresponding to the first quartile. We organized around 16 workshops and specialized meetings. Most relevant, the research teams have successfully fulfilled their commitments and milestones foreseen for this period, thanks to the dedication and hard work of our scientists.

An important role in the activity of the institute is the work on training, knowledge transfer and communication and outreach.

A large fraction of the IFCA personnel has a direct and intense participation in the undergraduate program of the University of Cantabria. Moreover we promoted two official (accredited by the National Education System,

ANECA) inter-university Master Programs with Universidad de Cantabria (UC) and Universidad Internacional Menéndez Pelayo (UIMP), with the collaboration of CSIC. The creation of the two masters was a strategic decision of the institute to promote two subjects of multidisciplinary research with great potential for collaboration across the IFCA research lines. The Master in Data Science started in the academic year 2017-2018, while the second Master in Particle Physics and Physics of the Cosmos is now in its first edition. These two Master Programs provide access to the PhD studies in “Science and Technology” from Universidad de Cantabria Doctorate School. The training activity of the institute has resulted in 23 PhD Theses in the last five years.

Our scientific activity results in a continuous collaboration with regional, national and international specialized industry and technology-based companies. On average, we closely collaborate with over 20 companies, ranging from the nuclear industry, qualified space companies, or IT corporations. Notably we have agreements with FAO-ONU in activities related with knowledge transfer and consulting since 2012, or more recently with the CERN Knowledge Transfer Group to promote novel technology products.

Our communication and outreach team has consolidated the presence of IFCA at a regional and national level. There is an intense program of events towards primary and secondary schools (over 100 events per year) that develop throughout the academic period, reaching more than 5,000 students. In addition, a similar number of events oriented to the general public are organized making use of a rich variety of platforms.

IFCA is firmly committed with inclusivity and gender equality in science, aspects that are always present in our communication and outreach activities, as well as in the internal IFCA policy. In 2018, CSIC recognized our institute with the Accessit, in the first edition of the award “Distintivo de *acreditación en igualdad de género*” (Distinctive accreditation in gender equality).

Thanks to the dedication and effort of all the IFCA personnel, researchers, technical personnel, administration and management, 2018 has been a successful year for the institute. We start 2019 with renewed enthusiasm to fully explore the new open opportunities.



Teresa Rodrigo Anoro  
Director of IFCA



Prof. Teresa Rodrigo Anoro  
Directora del IFCA

## BIENVENIDA

Presentamos en este documento el informe científico de 2018 del Instituto de Física de Cantabria (IFCA). El IFCA es un centro de investigación multidisciplinar cuyo objetivo central es el estudio de la estructura fundamental del Universo, desde los objetos más pequeños (Física de Partículas) hasta las estructuras más grandes (Cosmología, Astrofísica y Astronomía). También investigamos los fenómenos no lineales y el comportamiento colectivo de los sistemas físicos. Además de llevar a cabo investigaciones básicas de vanguardia, abordamos los desafíos globales de la sociedad como el tratamiento de Big Data, los desarrollos en Inteligencia Artificial, el Clima y el Cambio Climático, o participamos en iniciativas internacionales para proporcionar recursos computacionales en el paradigma de Ciencia Abierta.

Un pilar fundamental de nuestra investigación es la colaboración con las mayores agencias científicas y laboratorios (CERN, ESA, ESO, etc.), así como la participación en los proyectos internacionales más relevantes en nuestras áreas de interés (CORDEX, IPCC, EOSC-Hub, etc.). El nivel de excelencia de nuestra actividad en diferentes frentes hace de IFCA un centro de investigación reconocido internacionalmente. En noviembre de 2018 recibimos la acreditación como Unidad de Excelencia María de Maeztu, emitida por el Ministerio de Ciencia, Innovación y Universidades. Además del mérito científico del premio, este reconocimiento proporciona fondos adicionales y la posibilidad de solicitar convocatorias específicas para atraer a jóvenes talentos. Esta es una excelente oportunidad que sin duda fomentará la capacidad de investigación del instituto. El objetivo de nuestro proyecto María de Maeztu, que también se muestra en nuestro Plan de Excelencia 2017-2020, es reforzar las líneas de investigación actuales y ampliar nuestra producción científica mediante la explotación y promoción de las sinergias entre las diferentes líneas de investigación, y así aprovechar al máximo la composición singular de nuestro centro.

Durante 2018 el IFCA mantuvo los más altos estándares en su producción científica. Participamos en 230 artículos publicados en las principales revistas internacionales especializadas, 90% de los artículos corresponden al primer cuartil. Se organizaron en torno a 16 workshops y reuniones especializadas. Además de estas cifras, quizás lo más relevante es que los equipos de investigación han cumplido con éxito sus compromisos e hitos científicos gracias a la dedicación y el esfuerzo de todo el personal.

Un papel importante en la actividad del instituto es el trabajo de formación, transferencia del conocimiento, comunicación y divulgación.

Una gran parte del personal del IFCA tiene una participación directa e intensa en el programa de grado de la Universidad de Cantabria. Además, hemos promovido dos programas de Master interuniversitarios oficiales (acreditados por el Sistema Nacional de Educación, ANECA) con la Universidad de Cantabria (UC) y la Universidad Internacional Menéndez Pelayo (UIMP), y con la colaboración del CSIC. La creación de los dos Masters fue una decisión estratégica del instituto para promover dos temas de investigación multidisciplinar con un gran potencial de colaboración entre las líneas de investigación de IFCA. El Máster en Ciencia de Datos comenzó en el curso académico 2017-2018, mientras que el segundo Máster en Física de Partículas y Física del Cosmos se encuentra ahora en su primera edición. Estos dos programas proporcionan el acceso a los estudios de doctorado en “Ciencia y tecnología” de la Escuela de Doctorado de la Universidad de Cantabria. La actividad de formación del instituto ha dado como resultado 23 Tesis Doctorales en los últimos 5 años.

Nuestra actividad científica se traduce también en una colaboración continua con empresas regionales, nacionales e internacionales especializadas en la industria y empresas de base tecnológica. En promedio, colaboramos estrechamente con más de 20 compañías, desde la industria nuclear, compañías espaciales cualificadas o corporaciones de IT. Cabe destacar que tenemos acuerdos con la FAO-ONU en actividades relacionadas con la transferencia de conocimiento y consultoría desde 2012, o más recientemente con el Grupo de Transferencia de Conocimiento del CERN para promover productos de tecnología novedosa.

Nuestro equipo de comunicación y divulgación ha consolidado la presencia de IFCA a nivel regional y nacional. Existe un intenso programa de eventos hacia escuelas primarias y secundarias (más de 100 eventos por año) que se desarrollan a lo largo del período académico y nos permiten acceder a más de 5,000 estudiantes. Además, se organiza un número similar de eventos orientados a un público general, haciendo uso de una gran variedad de plataformas.

El IFCA está firmemente comprometido con la inclusión y la igualdad de género en la ciencia, aspectos que siempre están presentes en nuestras actividades de comunicación y divulgación, así como en la política interna del instituto. En 2018, el CSIC nos reconoció, con un Accessit en la primera edición del premio “Distintivo de acreditación en igualdad de género”.

Gracias a la dedicación y el esfuerzo de todo el personal de IFCA, investigadores, personal técnico, administración y gestión, 2018 ha sido un año exitoso para el instituto. Comenzamos 2019 con entusiasmo renovado para explorar las nuevas oportunidades abiertas.



Teresa Rodrigo Anoro  
Directora del IFCA

## **2. ORGANIZATION AND GOVERNANCE**

- 1. About IFCA**
- 2. Structure and Governance**
- 3. Research Lines and Support Units**
- 4. Infrastructures and Laboratories**
- 5. Human Resources**
- 6. Budget**



## 1. ABOUT IFCA



### Key figures:

**86 people**, including  
30 permanent  
researchers

**Six research lines**

**>200 papers/year** in  
top journals

**>2 M€/year** obtained  
in competitive calls

Awarded as one of  
the **top-50** Spanish  
research centers  
(Severo Ochoa –  
María de Maeztu).  
Programa).



The Institute of Physics of Cantabria (IFCA) is a multidisciplinary Joint Centre of the Spanish National Research Council (CSIC) and University of Cantabria (UC) oriented to perform research on **basic science** to understand the components of nature, from elementary particles (Particle Physics) to the largest structures of the Universe (Cosmology, Astrophysics and Astronomy) as well as nonlinear phenomena and the complex collective behavior of matter. We also address **social challenges** such as Big Data and Machine Learning, Climate and Climate Change, and Open Science. These research activities build on advanced supercomputing services (IFCA is part of the Spanish Supercomputing network, RES) and the development of instrumentation in the framework of international collaborations.

It was **created in 1995** through a cooperation agreement signed by José María Mato de la Paz (CSIC President) and Jaime Vinuesa Tejedor (UC Rector), being the first director of the center Xavier Barcons. IFCA has maintained a steadily growth since its creation, reaching its current size of about 86 people, with 30 staff researchers. It produces yearly more than 200 publications in the best journals in the respective fields and has nearly 40 active projects, obtaining an external funding of about 2 M€/year, more than 80% of the total budget of the Institute.

IFCA has its own **building**, the Juan Jordá Building (in honor of Professor Juan Jordá, UC rector that promoted the consolidation of the institute) on the campus of the University of Cantabria in Santander. The building has 4 floors and more than 3000 square meters for researchers' offices, four meeting rooms (including an events room of 50 places), laboratories, and a computing data center on the ground floor hosting the Altamira supercomputer (part of Spanish Supercomputing Network, RES) and grid and cloud infrastructures maintained by the Advanced Computing Group contributing to international infrastructures.



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## 2. STRUCTURE AND GOVERNANCE

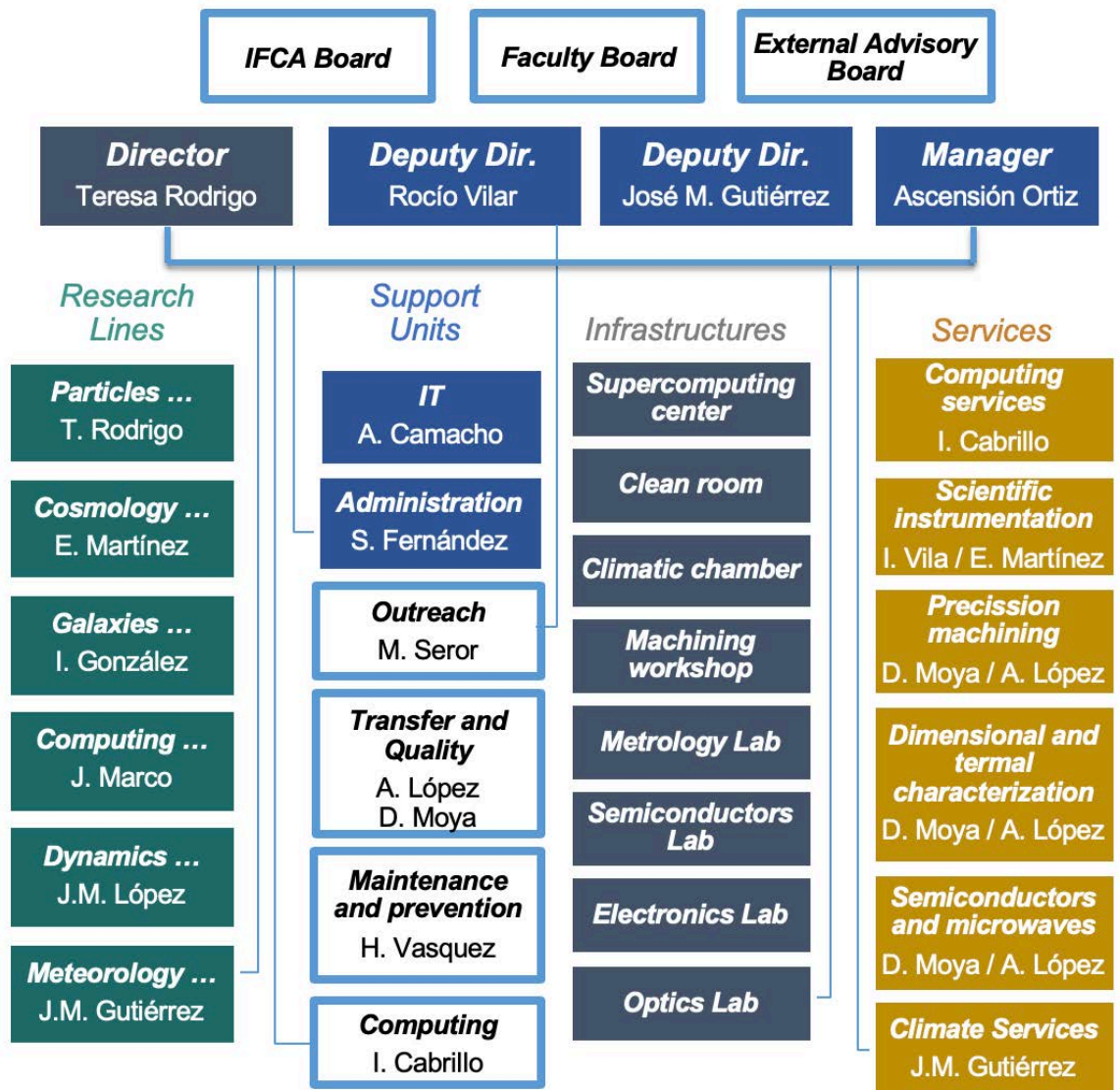
The Institute has a Director (Teresa Rodrigo), two deputy directors (Rocío Vilar and José Manuel Gutiérrez) and an administrative and economic manager (Ascensión Ortiz). The two main governance organs of the Institute are the IFCA Board (Junta) and the faculty consulting board (Claustro). The former has the attribution to advise and inform the Director on all matters that affect its operation and to approve the budget, strategic plan and the annual report of activities. The latter is the forum for the deliberation and approval of scientific issues and plans. During 2018 an external advisory board was established including six reputed researchers covering the main research topics of the Institute.

The Institute is organized in six research lines (from two Departments: Structure of matter and Astrophysics) and two support units (administration and IT, with two and four staff members, respectively). There are also five additional support staff depending on the direction which are responsible of different structural activities (outreach, transfer and quality, maintenance and prevention and computing).

**IFCA External Advisory Board:**  
 Daniela Bortoleto (UK)  
 Marcella Diemoz (Italy)  
 Jurgen Kürths (Germany)  
 Norbert Meyer (Poland)  
 Brigitte Rocca-Volmerange (France)  
 Joseph Silk (France)

### IFCA Organigram.

The two main governance organs of the Institute are the IFCA Board (Junta) and the faculty consulting board (Claustro), as well as an external advisory committee. The Institute is organized in six research lines, assisted by two support units and several support staff responsible of different support activities. A number of services are offered building on the existing labs and infrastructures.



During its over 20 years of existence IFCA has managed to consolidate solid and well-established research groups working in frontier physics lines and it treasures today a powerful combination of theoretical and experimental/observational research capability on basic science. These research activities are organized in six research lines, each including different groups and/or sublimes:

**VISION for 2020:**  
Our vision for 2020 is to make IFCA, with the support of MDM Excellence award, a consolidated unit of international standards developing top class basic research in Physics, gaining world class positioning through leadership in frontier research projects, and a reference centre in those subjects where the multidisciplinary interplay is key for the advancement of knowledge.

- **Particle Physics and Instrumentation:** Concerned with the fundamental constituents of matter and the laws that describe its dynamics by performing experiments using powerful particle accelerators and complex detectors. We collaborate in the CMS experiment of the Large Hadron Collider (LHC), and the DAMIC-M experiment for direct Dark Matter search.
- **Observational Cosmology and Instrumentation:** Concerned with the study of the origin and evolution of the universe through cosmological observations including the Cosmic Microwave Background and the galaxy distribution, participating in the design and development of instrumentation and in the analysis of astronomical data in collaborations such as QUIJOTE and PLANCK.
- **Galaxies and AGNs:** Conducts multi-wavelength observational investigations to understand the growth of super-massive black holes and the interplay with galaxy evolution. In addition we also collaborate in the design and development of future astronomical instruments, particularly X-ray astronomy missions such as Athena.
- **Nonlinear Dynamics:** We investigate nonlinear and stochastic phenomena using both theoretical/computational and experimental methods, with especial interest in high-dimensional chaos and collective behavior, noise and fluctuations in physical systems, and nonlinear effects in semiconductor lasers.
- **Advanced Computing:** Develops and deploys advanced HPC, grid and cloud computing software and middleware to solve complex scientific problems in several disciplines. We participate in international initiatives in the framework of the European Open Science Cloud, such as EGI and INDIGO-DataCloud, EOSC-Hub, etc.
- **Meteorology and Data Mining:** Concerned with regional climate variability analyzing huge amounts of data (from observations and model simulations) using statistical and machine learning techniques, focusing on seasonal forecasting and climate change. We participate in international collaborations such as IPCC and CORDEX.

Besides its own resources and installations, IFCA manages research and outreach infrastructures and project offices and has two associate research units:



The **Astronomical Observatory of Cantabria (OAC)** is an installation of the Government of Cantabria, scientifically managed by the University of Cantabria (UC) through IFCA (the current director is Amalia Corral, of the Galaxies and AGN group) with the participation of the Astronomical Association of Cantabria (AAC). OAC carries out both scientific and outreach activities and it is open to the general public and schools for guided visits and observing sessions during the summer months, welcoming around 3000- 4000 people every year.

# ATHENA:

IFCA hosts the **Athena Community Office**, supporting ESA's *Athena* Science Study Team in the coordination, organization, and communication of the growing community, and in dissemination activities.

CSIC contemplates the creation of “**associated units**” in order to strengthen the collaboration with other institutions in the promotion and transference of science and technology, as well as collaboration with universities in activities of scientific research and technological development. IFCA has two Associate Units:



VNIVERSITAT  
DE VALÈNCIA



- **Cosmology and Extragalactic Astrophysics Group from Valencia University**, collaborating with the Galaxies and AGNs and Observational Cosmology and Instrumentation IFCA Groups (October 2012 - June 2019).
- **Meteorology and Computation Group of University of Cantabria**, collaborating with the Meteorology and Data Mining IFCA group (in process of creation for 2019-2021).

### 3. RESEARCH LINES AND SUPPORT UNITS

#### PARTICLE PHYSICS AND INSTRUMENTATION

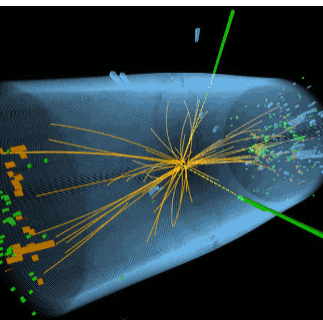
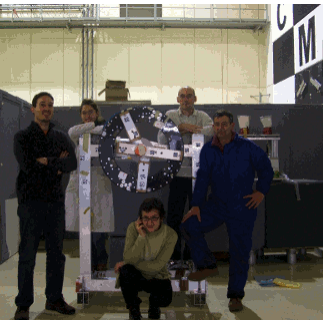
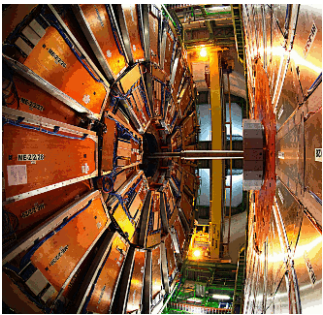


The IFCA Particle Physics and Instrumentation (PP&I) group participates in world-class international research projects, covering a rich spectrum of research activities.

We seek to understand the fundamental questions in Particle Physics and contribute to the R&D and development of scientific instruments employing the

forefront technologies. The two main research lines are: Experimental Particle Physics and Instrumentation and Particle Physics Phenomenology.

Since its foundation, back in the 80's, the group has participated in the major experiments of the field. Members of the group were actively involved in the CERN Large Electron-Positron Collider (LEP) DELPHI experiment, with a strong participation in physics analysis. In the 90's we joined the CDF (Collider Detector at Fermilab) experiment at the Fermi National Accelerator Laboratory (FNAL) and participated in a broad program of physics as well as in the construction and operation of the Time of Flight detector included in the upgrade program of CDF-II. A major share of the PP&I group activities today focuses on the Compact Muon Solenoid (CMS) experiment at CERN. Moreover members of the group joined recently a non-accelerator based experiment, DAMIC/DAMIC-M (Dark Matter in CCDs/ Dark Matter in CCDs at Modane), an underground experiment to search for the elusive particles that we think are the constituents of the dark matter present in the universe. The participation in running experiments is complemented with R&D in detector instrumentation, and new research facilities.



In connection with the ongoing experimental effort, there is also a small but active phenomenology group involved in developments and tests of the Standard Model of Particle Physics and its Supersymmetric extensions. The main focus is on the search for new physics at the LHC and future colliders (ILC, CLIC, HL/HE-LHC, FCC, etc.), channeled via the participation in national and international thematic networks and working groups.

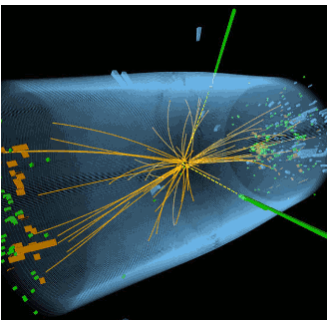
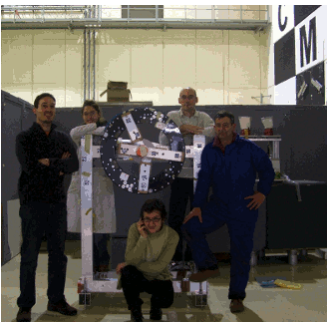
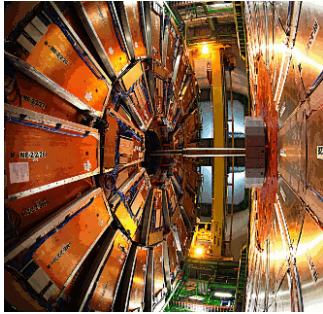
Members of the group participate in teaching at the University of Cantabria (UC) at all levels, and we also provide joint programs of masters with other IFCA research groups. Two interuniversity

masters (UC and UIMP) are currently available. An average of 1-2 PhD theses per year are defended in the group.

The group is actively committed to education and outreach activities for the public promotion of particle physics, and fundamental research in general.

### INTERNATIONAL PROJECTS AND COLLABORATIONS:

**CMS** is a general-purpose detector at the CERN Large Hadron Collider (LHC). It has a broad physics programme covering the study of Standard Model (SM) processes, including the Higgs Boson, and the search for signatures beyond the SM, in proton-proton and heavy ion collisions at today's highest reachable energies. The experiment is one of the largest international scientific collaborations, involving more than 4000 physicists, engineers, technicians, students and support staff from 42 countries. In 1994 the IFCA group joined CMS, contributing since then to the construction and operation of the detector and the Grid computing infrastructure (Tier2 and Tier3). Nowadays our main focus is on physics analysis and detector upgrade activities for the High Luminosity phase of LHC (HL-LHC).



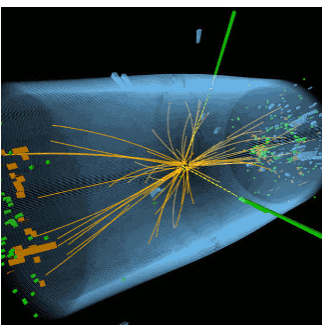
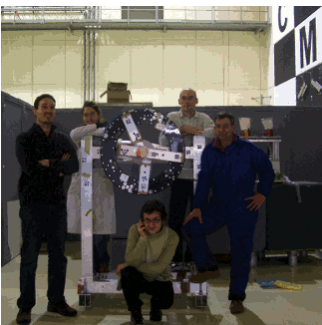
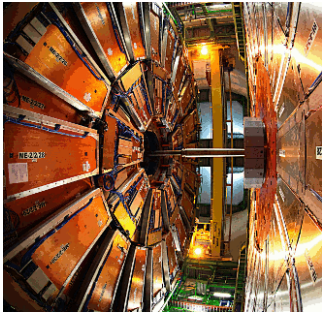
In the early days, we designed, constructed and operated an opto-mechanical alignment system (Link System) for the online monitoring and alignment of the Muon spectrometer of CMS, which involved high precision measuring devices, together with laser paths and multipoint position photo-sensors. Today we focus on the development and testing of semiconductor Silicon detectors (3D and planar sensors, HVCMOS, etc.) for the HL-LHC upgraded Pixel detector, together with R&D for the new and promising proposals of Precision Timing detectors using, among others, LGAD technologies.

The group also makes a major contribution to software development (simulation, reconstruction, data validation, object definition, data preservation and open data, etc.). Our participation in physics analysis ranges from SM measurements (mainly on diboson production and top quark physics), Higgs Boson physics, and the search for new BSM signatures (Dark Matter candidates, SUSY signatures, long lived particles, etc.). The quality of the contributions is reflected in responsibility positions within the CMS physics organization, successively assigned to members of the group.

The **DAMIC** experiment uses high resistivity, scientific grade CCDs to search for dark matter. The CCD's low electronic noise allows an unprecedentedly low energy threshold of a few tens of eV.

The experiment has a unique sensitivity to dark matter particles with masses below 6 GeV.

R&D initial results demonstrated the potential of this technology, motivating the construction of larger versions of the detector. DAMIC100, with approximately 40 grams of silicon target detector, is currently being installed at SNOLAB. The next step is the construction of DAMIC-M at the Modane under-ground laboratory in France. DAMIC-M will be able to progress further in the search for low-energy dark matter particles, including the GeV-scale WIMPs (Weakly Interacting Massive Particles), the hidden-photon, ALP (Axion Like-Particles), and to probe a large region of parameter space for dark matter particles in the “hidden sectors” (not directly coupling with ordinary matter) and having masses from 1 MeV to 1 GeV.



The collaboration is composed of 11 research institutes from Europe, the US, and Latin-American countries. Our group contributes to data-taking and analysis of the current DAMIC configuration, and to develop software (DQM system and GEANT simulations) for the new upgraded DAMIC-M version, to test the new CCD cameras, and to qualify in terms of radio-purity new detector components, in collaboration with the Underground Canfranc Laboratory (LSC).

## **INSTRUMENTATION R&D AND FUTURE EXPERIMENTS**

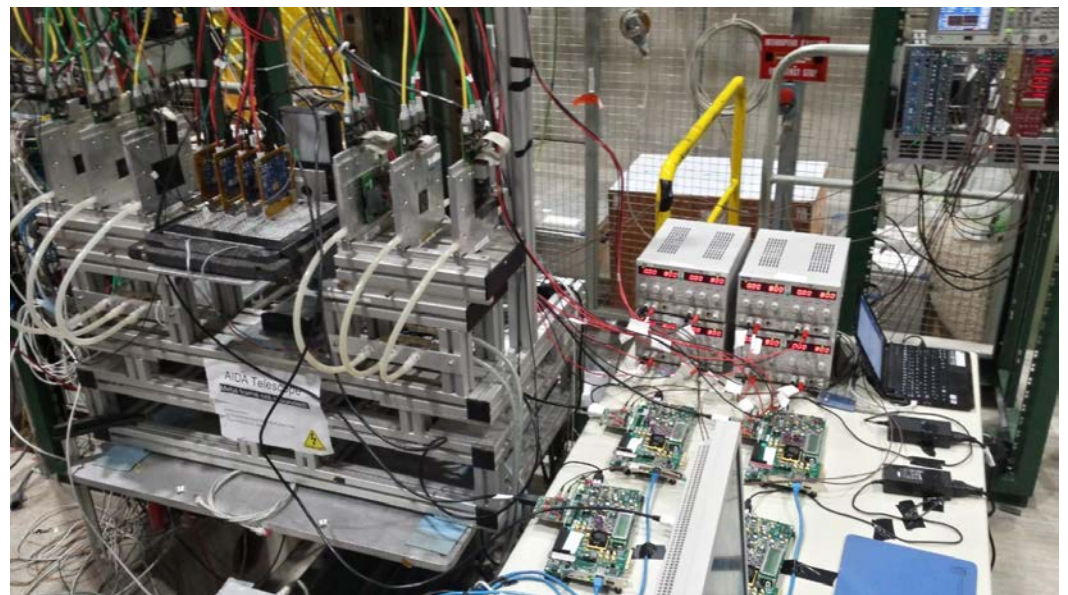
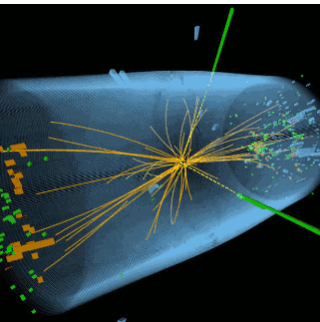
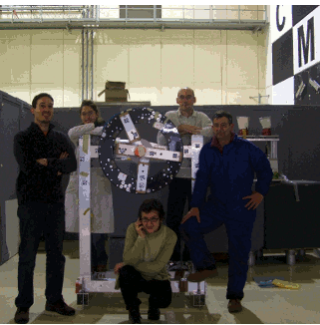
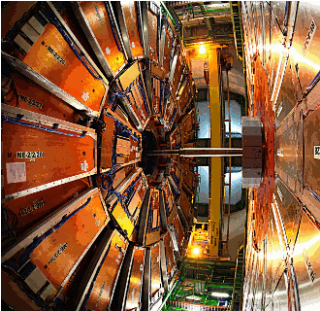
The development of new instrumentation is at the core of the particle physics quest; new tools allow us to explore uncharted nature territories for the discovery of new physics phenomena. IFCA’s PP&I group has been involved in instrumentation development since its foundation.

A large fraction of this R&D program is carried out inside the CMS collaboration as part of the High-Luminosity upgrade activities. Our group is leading the development and assessment of pixelated silicon sensors with vertically etched junctions (3D pixel sensors), an extreme radiation-tolerant technology for the innermost Inner Tracker layer. We are also contributing to the radiation tolerance and detection efficiency optimization of Low Gain Avalanche Detectors (LGAD), a technology that members of our group contributed to introduce in experimental particle physics. LGAD is a fast-response sensor and the baseline sensing technology of the new endcap CMS sub-detector for the precise time stamping of minimum ionizing particles.

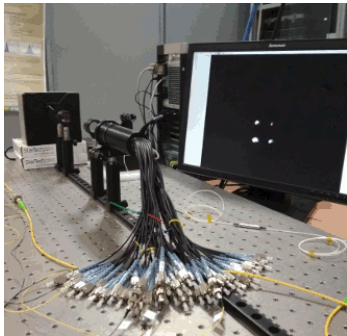
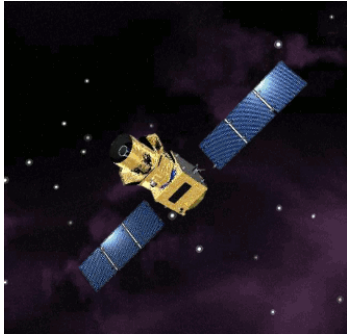
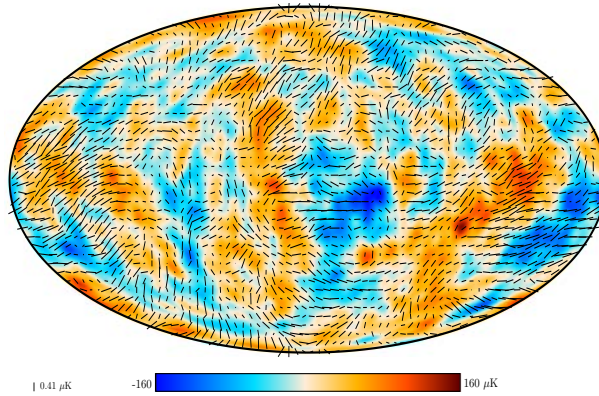
A more generic R&D line is pursued as members of the “*Radiation hard semiconductor devices for very high luminosity*”

*colliders*” (RD50) collaboration at CERN and as partners of the long family of EU funded projects “Advanced European Infrastructures for Detectors at Accelerators” (EUDET, AIDA and AIDA-2020). Some of these activities are targeting possible future experiments: ILC, CLIC, FCC or CepC. In particular, the PP&I group has played an important role in the detector R&D for future linear electron-positron colliders inside the Spanish particle physics community. A contribution that stands out is the introduction of an improved LGAD architecture, named iLGAD, which solves the intrinsic spatial efficiency limitation of the original LGAD devices and could become the enabling technology for the ultimate 4-dimensional particle trackers.

All these activities are performed within international collaborations. Among them, we should point out our close collaboration with the Solid State Detector lab at CERN, the INFN-Florence and the University of Hamburg. Most of the activities are developed within the framework of the Spanish national research plan, in very close collaboration with the Instituto de Microelectrónica de Barcelona (IMB-CNM), the Instituto Tecnológico de Aragón (ITAInnova) and the Universidad de Sevilla.



## OBSERVATIONAL COSMOLOGY AND INSTRUMENTATION



surveys. The group is internationally recognized for their expertise on the isotropy and Gaussianity of the universe, the component separation process to obtain the CMB signal and compact sources, and the gravitational lensing analysis of galaxy cluster images. Its activities also include development and calibration of CMB instruments at the low frequency range, where it maintains a long collaboration with the microwave group of the Department of Communications Engineering of the Cantabria University. In particular, it is developing a demonstrator of a microwave polarization interferometer with an optical correlator and also has proposed a calibration satellite for future CMB polarization missions.

The group is involved in some of the most relevant CMB experiments, such as Planck, QUIJOTE and LiteBIRD, and large scale structure projects, such as the Hubble Frontier Fields and its continuation, BUFFALO, JPAS and Euclid.

The group actively participates in the coordination of the European CMB activities (Enrique Martínez-González being a member of the ECMB coordination committee including 8 people from the 4 main European countries), and has recently joined the LiteBIRD collaboration through the European consortium (Enrique Martínez-González is a member of the Steering Committee).

### INTERNATIONAL PROJECTS AND COLLABORATIONS:

**Radioforegrounds.** The group is highly involved in the characterization of the microwave foregrounds at the low frequency range and in the prediction of realistic forecasts for future CMB polarization experiments within the COMPET-5, H2020 project of the EU. R.Belén Barreiro is the local PI of the project.



**Planck mission.** The group has participated in the ESA Planck mission from its beginning in 1993, playing roles of Co-I and Planck Scientist. Members of the group have coordinated the isotropy and statistics and ISW groups and the production of the catalogue of compact sources, and have produced one of the four official clean CMB maps.

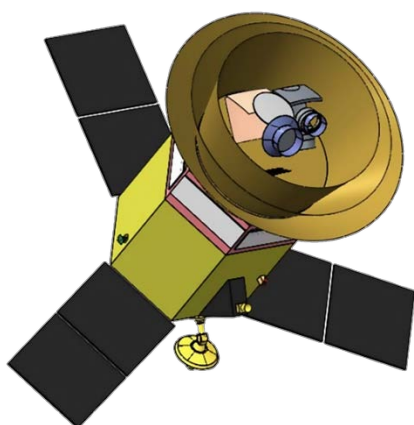
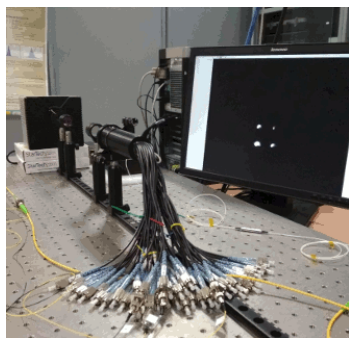
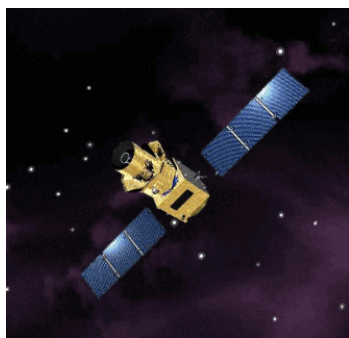
**QUIJOTE experiment.** We are one of the 5 teams that constitute the consortium: IAC (leader), IFCA, DICOM-UC, U. Manchester and U. Cambridge. Our group had and still has a major role in the development of the QUIJOTE experiment and is represented in the Executive Board.

**JPAS** (Javalambre Physics of the Accelerated Universe Astrophysical Survey). The group participates in the Clusters of Galaxies and Theoretical Cosmology and Fundamental Physics working groups with Jose María Diego co-coordinating the former.

**LiteBIRD** (Lite satellite for the studies of B-mode polarization and Inflation from cosmic microwave background Radiation Detection). Members of the group actively participate in the JAXA LiteBIRD mission that is now being evaluated for selection.

**BUFFALO** (Beyond Ultra-deep Frontier Fields and Legacy Observations). This project is the continuation of the Hubble Frontier Fields (HFF) where José María Diego has played a major role in recent results of lensing and micro-lensing effects derived from HFF images of rich clusters of galaxies.

**Other long-term projects:** **Euclid** ESA mission to map the geometry of the dark universe. Several members of the group belong to the Euclid consortium. **SKA/ASKAP**, where members of the group participate in the Cosmology and Reionization working groups. **JWST Medium-Deep-Fields**, where José María Diego participates in the first proposals of GTO with 100+ hours.



## GALAXIES AND AGNs



The group investigates galaxy evolution along cosmic history. In particular, discovering how and when stars formed in galaxies, how and when supermassive black holes in their centers grew and what is the relation between both processes, known as feedback. These studies span from the local Universe to the first and more distant galaxies formed, but with

special emphasis in the epoch of major activity when the Universe was had 20%-50% of its current age ( $z \sim 1-3$ ).

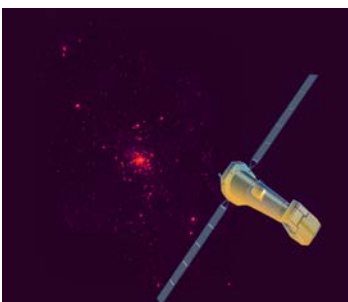
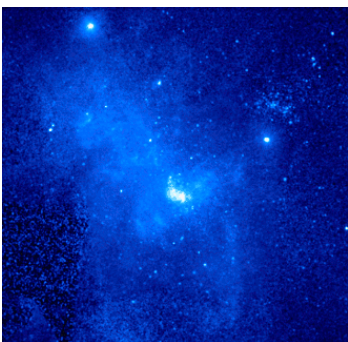
For this purpose, the group carries out astronomical observations across the electromagnetic spectrum, from radio, infrared or optical to the X-rays, both for particular sources and as part of multi-wavelength surveys (leading some of them, such as the Bright Ultra-hard XMM-Newton Survey -BUXS-). Competitive access to the most relevant astronomical ground (VLT and ALMA in ESO, IRAM, VLA/Jansky, Effelsberg, EVN, GTC, ORM, CAHA, etc.) and space (XMM-Newton, Spitzer, Herschel) observatories is an essential asset in the group, since scientific achievements are often driven by such observations.

Regarding the large astronomical infrastructures and their related advanced instrumentation, the group participates in leading positions in the most competitive projects at Spanish, European and world-wide level. These activities are considered by the group as a strategic target. Some members of the group have relevant roles in future space missions such as *Athena* (ESA), and in ground observatories like GTC, OAJ and ESO.

The group participates assiduously in the outreach tasks of both IFCA and the Athena Community Office (Science Week, Open Doors, Expanding Science - even more, February 11th, Researchers' Night ...), organising some of them. In this regard, it is worth mentioning the management of the Astronomical Observatory of Cantabria by members of the group.

### INTERNATIONAL PROJECTS AND COLLABORATIONS:

[Athena](#) (the Advanced Telescope for High ENergy Astrophysics) has been selected by ESA as the second mission of its Cosmic Vision programme, to address the Hot and Energetic Universe science topic. After adoption in 2021 and launch in the early 2030s

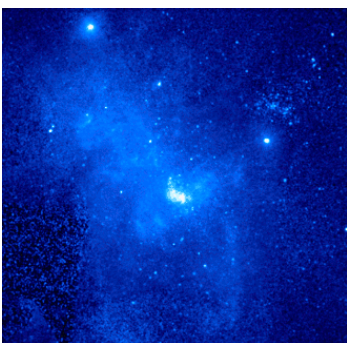


it will be a revolutionary space X-ray observatory addressing the above topic and impacting all corners of Astrophysics. The group participates in the scientific definition of the mission, with membership in several topical panels.

At the mission level, the group's main responsibility is hosting and heading (Francisco J. Carrera) the **Athena Community Office** (ACO). The ACO has been established by ESA's Athena Science Study Team to support its role as “focal point for the interests of the broad scientific community”, including coordination, organization, and communication for the community and outreach activities for the general public.

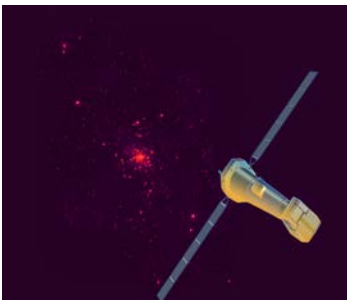


The group also has as significant participation in the **X-IFU Consortium**, in charge of providing a groundbreaking cryogenic spatially resolved high resolution spectrograph for Athena. M.Teresa Ceballos is X-IFU Instrument co-Investigator, manager of the Event processor algorithm Subsystem, member of the end-to-end simulation team and the X-IFU Instrument Consortium Center and Consortium Member (in these last three categories along with Beatriz Cobo). Xavier Barcons is also Science Co-investigator and Consortium member.



**SPICA** is a space infrared observatory preselected by ESA for its M5 slot. The team participates in its scientific definition, in particular for its synergies with Athena for the study of the obscured growth of supermassive black holes

The Advanced Large, Homogeneous Area Medium Band Redshift Astronomical (**ALHAMBRA**) Survey was a photometric survey in 20 contiguous bands, finished in 2014, in which Alberto Fernández Soto participated.

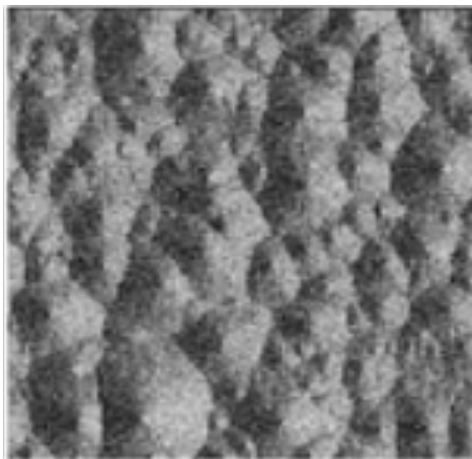


**OTELO** is one of the deepest emission lines surveys to date, carried out with the GTC in the Canary Islands. It has just been completed and it will release the catalogue soon. Ignacio González Serrano is a member of the Core team.

Two members of the team (Ignacio González and Alberto Fernández) also participate in **J-PAS** (already defined above), being observed at the Javalambre observatory in Teruel (Spain).

ATHENA:

## NONLINEAR DYNAMICS

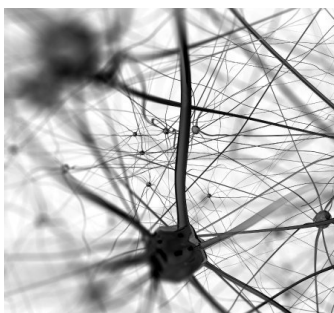
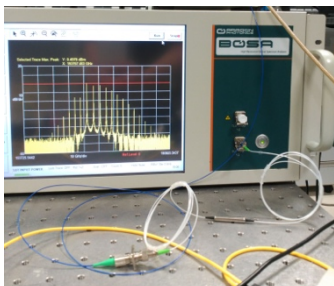
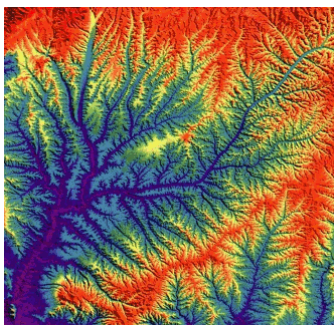


Investigates nonlinear and stochastic phenomena in physical systems. Our approach is both theoretical/computational and experimental. Topics of our research include high-dimensional chaos, and effects of noise and fluctuations in physical systems. We are specially interested in generic properties of

dynamical systems where the (nonlinear) interaction between many degrees of freedom leads to complex collective behavior. Our experimental research is focused on nonlinear effects in semiconductor lasers.

Our research is organized in two lines:

- 1) **Nonequilibrium statistical physics and chaos:** Nonlinear transport in many-body systems, instabilities and chaos in extended systems, surface growth, critical phenomena, and disordered systems.
- 2) **Photonics:** Nonlinear behavior of vertical-cavity surface-emitting semiconductor lasers (VCSELs), in particular when subject to optical injection or optical feedback. Our aim is to perform experimental and theoretical studies for applications in optical communication systems.



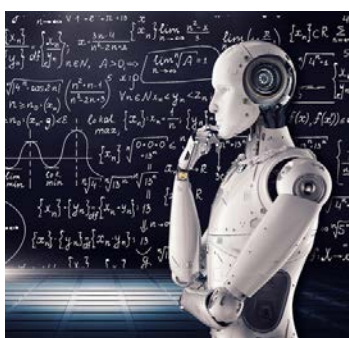
### INTERNATIONAL PROJECTS AND COLLABORATIONS:

The Group has participated in a number of initiatives aiming at deploying **machine learning methods on photonic systems**. For instance, the aim of the European project PHOCUS (Towards a photonic liquid state machine based on delay-coupled systems) was the study of a novel photonic system able to process information in an efficient and fast way. The basic idea is to use semiconductor lasers subject to delayed feedback to generate a high-dimension space. In this way we pretend to substitute the neural networks based on hundreds of components by a small number of coupled photonic components. This photonic system will permit high-speed information processing (in the MHz-GHz range).

## ADVANCED COMPUTING

The global objective of the **Computing and E-Science Group** is to make a relevant contribution in Data Science in analytics, engineering and open data, in different science fields, and in particular in interdisciplinary applications, profiting from the computational resources available. In particular, the group

- 1) contributes to the analysis of large data volumes, like CMS experiment at LHC, using Big Data techniques,
- 2) integrates the different components for applications in environmental science, from sensors and data taking up to simulation and modeling,
- 3) participates in projects at national and international level.



The technical objectives of the group are to maintain and improve the computing infrastructure managed by the group, currently including a supercomputer, several clusters, an storage system with a capacity above 1 Petabyte, and an archiving system with an equivalent capacity, and assure its exploitation in demanding and outstanding projects at national and international level.

Our centre hosts a node in the Spanish Supercomputing Network, coordinated by the BSC in Barcelona. This fact contributed to our general interest on advanced computing techniques, including the mechanisms for their integration.

Our team has developed joint solutions in different fields like:

- the TRUFA pipeline in genomics in collaboration with the MNCN
- Complete modelling of a water reservoir using DELFT 3D in collaboration with ECOHYDROS (SME)

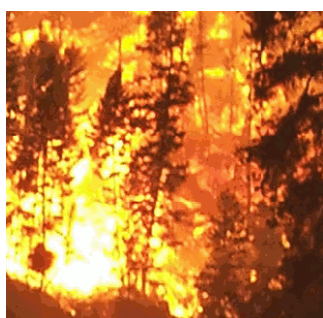
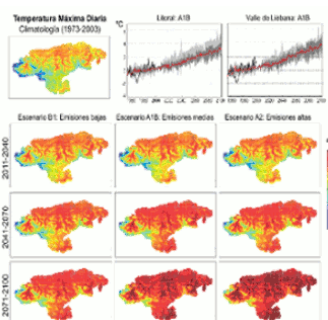
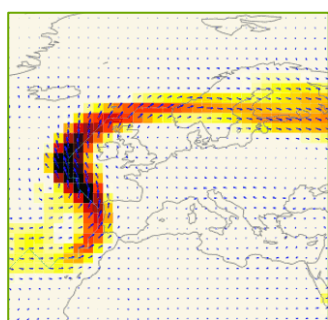
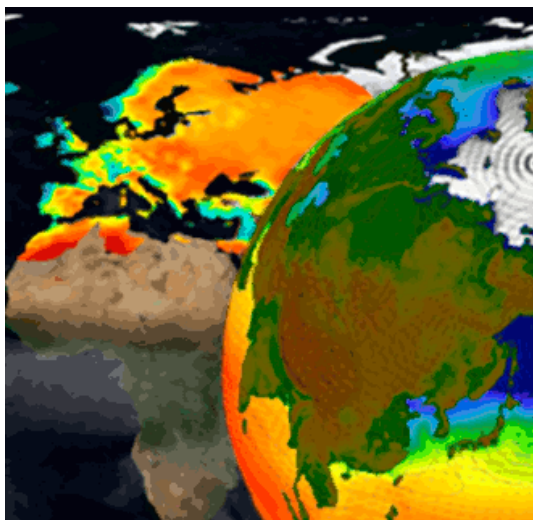
The **Distributed Computing and Grids Group** focuses on the development of distributed computing architectures at pan-European level: federated identity systems for user authentication, advanced software for cloud environments, and data management in distributed infrastructures. The group puts special emphasis on the applicability to scientific use cases.



### INTERNATIONAL PROJECTS AND COLLABORATIONS:

In the last years we have evolved towards Cloud computing. IFCA supports the FedCloud infrastructure, participates in the EGI-Engage and INDIGO-DataCloud H2020 projects. The group has a strong visibility at the European level in the development of the European Open Science Cloud (EOSC).

## METEOROLOGY AND DATA MINING



The main research activity of the group is the regional climate analysis and prediction focusing on seasonal and multi-decadal time scales (seasonal prediction and climate change projections). To this aim, the group has recognized expertise using regional climate models and statistical downscaling

methods (currently focusing on machine learning methods). This activity builds on the specialized technical infrastructure deployed by the group for climate data storage and access, contributing to several European and international initiatives (e.g. the Earth System Grid Federation, ESGF). The group has also experience in the development of open source tools and web applications (in collaboration with the spin-off company [Predictia](#)), which are widely used by the regional climate community (e.g. the statistical downscaling [portal](#), [climate4R](#), or the national scenarios [portal](#)).

These activities are done in collaboration with the “Meteorology and Computing” group from University of Cantabria (4 senior researchers). The creation of an **IFCA Associate Unit** is in process to formalize this collaboration for the period 2019-2022.

The group coordinates a CSIC platform for the development of climate services (building on the experience acquired in the IPCC and COPERNICUS) and participates in world-class international collaborations in the topic of regional climate downscaling.

### INTERNATIONAL PROJECTS AND COLLABORATIONS:

**Intergovernmental Panel on Climate Change (IPCC).** The group is highly involved in the next Assessment Report (AR6), coordinating the development of the Interactive Atlas, a new product that will be supported by CSIC/IFCA. José M. Gutiérrez is Coordinating Lead Author (CLA) of the Atlas WGI Chapter.

**Coordinated Regional Climate Downscaling Experiment (CORDEX).** The group coordinates EURO-CORDEX statistical downscaling and distillation activities. Moreover, José M. Gutiérrez is member of the Science Advisory Team (SAT), which coordinates activities worldwide.

### 3. RESEARCH LINES AND SUPPORT UNITS

#### INFORMATION TECHNOLOGIES

Responsible:  
Angel Camacho

In order to assist the research activities the IFCA has two support units: Information Technologies (IT) and Administration:

The **Information Technologies Unit** is responsible for the set of typical activities of a Computer Service, including user support, for the definition, implementation and administration/maintenance of systems and services in relation to:

- Equipment hardware.
- Support for basic software.
- Network infrastructure and protocols. Service levels.
- Collaborative work (mail, web, videoconference, etc).
- Politics and physical and logical security mechanisms.
- Network management (VLAN, security, load balancing, communities, connectivity, etc.).
- Monitoring of the global system.
- Procurement management, maintenance, incidents, repairs.

The IT Unit also support users in all aspects related to information and communication technologies.

#### ADMINISTRATION

Responsible:  
María Ascensión Ortiz  
(UC)  
Silvia Fernández  
(CSIC)

The **Administration Unit** is responsible for the administrative and economic management of the Institute (for both CSIC and University of Cantabria), including running operating expenses, trips and all hiring issues (personnel and services). The Unit is also responsible of the administrative matters related to the research projects (payments, justifications, audits, etc.).



## 4. INFRASTRUCTURES AND LABORATORIES

IFCA research activities are supported by laboratories with high-performance technological equipment, which have enabled the participation of IFCA groups in large research projects and meet the increasingly demanding scientific needs. At the same time, the availability of unique technical resources has enabled the development of capacities at the service of society.



**Metrology Laboratory:** Is devoted to component testing (optical sensors, lasers, gradient sensors, etc.) and to perform full-scale system tests. The reinforced concrete floor is independent from the structure of the building to avoid vibrations in the most accurate optical system tests.

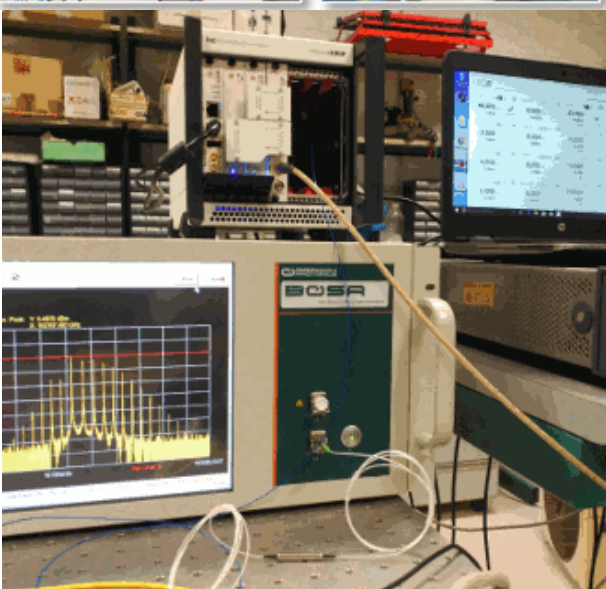
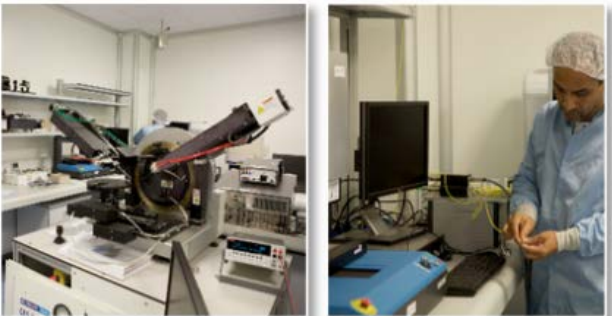
**Clean Room (30 m<sup>2</sup>):** Certified under ISO 9001 since 2000 it has been equipped to maintain a clean environment (class 5.5 according to ISO 14644) and a 6 m<sup>2</sup> access area (SAS class 8). It has also a conducting floor and a real time particle-monitoring device.

**Thermal Chamber:** With a working volume of 180 litres, temperature range of -70 to 100° C and 0.1° C resolution is also available at IFCA.

**Mechanical Workshop:** Equipped with a CNC milling machine and CNC lathe.

These facilities allow the assembling, calibrating and tuning of high precision optical sensors, as well as electronic devices like low noise amplifiers, enabling an active R&D line on solid-state position-sensitive-detectors and microwave receivers.

**Optical Communications Laboratory:** Equipped with a pulse and frame burst generator with error detector that allows light source modulation and channel characterization up to 12.5 Gb/s.





**Supercomputing Infrastructure:** Our center hosts, operates and benefits from a relevant computing infrastructure, such as the ALTAMIRA node of the Spanish Supercomputing Network (a Singular Scientific and Technological Infrastructure – ICTS), and the IFCA grid and cloud resources (integrated into the EGI and EOSC EU e-infrastructures). More than 2 PB of storage, jointly with the computing power and the connection by dark fibre to the Spanish NReN, RedIris, enable IFCA to exploit large data sets in international frontier research projects.

More info at: <https://ifca.unican.es/en-us/about-ifca/infrastructure>



The UC Meteorology and Computing Affiliated Unit provides additional infrastructure specialized in **climate services** (1 PB).

> 375 nodes with ~11440 cores (> 80 Tflops):  
Local Cluster, Cloud and Grid

High bandwidth and low latency Infiniband FDR10 network, 10Gbps Ethernet network

IFCA hosts the Altamira supercomputer (part of the National Supercomputing Network, RES) and IFCA computing infrastructures (grid and cloud) contribute to key international initiatives, including Ibergrid, EGI.eu and EOSC.

Flexible storage: Block, Object and File System, through middleware CEPH (300TB) and Spectrum Scale (1.5PB) and Lustre (1PB).

Backup service with IBM TS4500 robot and LT0 7 drives, supervised by Bacula software



RED ESPAÑOLA DE SUPERCOMPUTACIÓN



**EOSC-hub**



IFCA lab (150 m<sup>2</sup> conditioned) for supercomputing infrastructures.

## 5. HUMAN RESOURCES

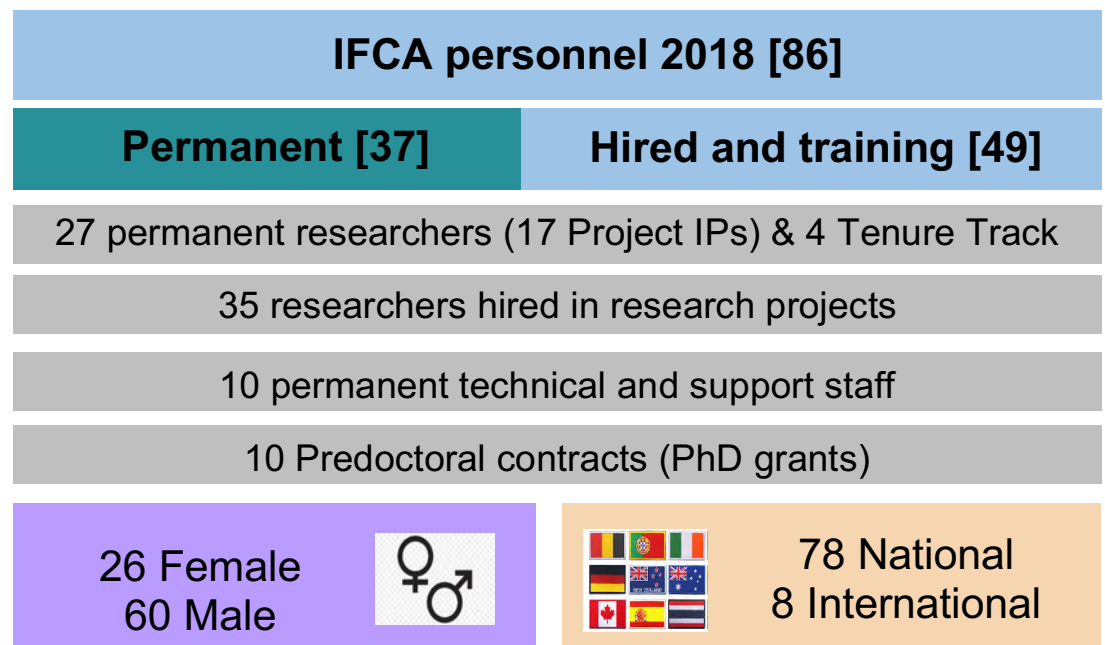
IFCA human resources are from CSIC (Ministry of Science, Innovation and Universities) and from University of Cantabria, with a good balance between both institutions (nearly 50% from each). Overall the size is of 76 researchers (27 permanent, 4 tenure track and 45 hired by research projects/grants) and 10 technical and administration staff. Tenure track positions include Ramón y Cajal, and Profesor Ayudante Doctor. It is remarkable the number of hired researchers decreased in the first half of the last five years period due to the difficulties that public R&D system suffered in Spain; however, this is now quickly recovering due to the high success of the Institute in competitive calls.

	2014	2015	2016	2017	2018
<b>Tenure Researchers</b>	25	25	25	26	27
<b>Tenure Track</b>	3	3	4	3	4
<b>Hired researchers</b>	40	38	28	30	35
<b>Training</b>	0	2	5	3	0
<b>Predocctoral fellows</b>	8	9	5	6	10
<b>Support staff</b>	10	10	10	10	10
	<b>92</b>	<b>87</b>	<b>77</b>	<b>78</b>	<b>86</b>

The diagram below shows the distribution of the human resources by categories, sex and nationality corresponding to 2018:

Distribution of researchers (permanent 'P' and hired 'H') in the different research lines:

- **Particles**  
9 P + 16 H
- **Cosmology**  
5 P + 11 H
- **Galaxies**  
4 P + 7 H
- **Nonlinear**  
4 P + 2 H
- **Computing**  
3 P + 10 H
- **Meteorology**  
2 P + 5 H



## 6. BUDGET (2018)

In order to accomplish the proposed tasks, the Institute has a single functional budget constituted by the nominal contributions of CSIC and University of Cantabria for the salaries of the staff personnel (researchers, technicians and services) and for the running operation expenses (water, electricity, maintenance, etc.). Additional funding is obtained from public and private calls and from research contracts with Administration and Industry.

### 2018 BUDGET

BUDGET for running operation expenses (Chapter II funding):

CSIC: 39355 €

UC: 7890 €

in addition, UC pays for electricity (~155k€), water (~4500€), surveillance (~8000€) and other maintenance expenses (~10000€).

BUDGET for infrastructure acquisition:

CSIC: 6213€

BUDGET from project overheads

CSIC: 188720€ (21% of project overheads)

UC: 5521€

In addition, UC has a number of calls for predoc contracts, etc. funded with project overheads.

**Total funding (2018): 253912€**

**Expenses (2018): 132705€ (see table below)**

**Overall 2018 balance: +121207€**

	2018
COFINANCIACIÓN PLAN ESTRATÉGICO/EQUIPA	0
COFINANCIACIÓN PERSONAL	26371.74
COFINANCIACIÓN FEDER	0
ALQUILERES (IMPRESORAS)	8229.77
ADQUISICIONES BIBLIOGRÁFICAS (RSEF)	90.00
FUNGIBLE	3549.79
INVENTARIABLE	2524.38
DIETAS Y VIAJES	6348.94
PERSONAL	2061.8
OTROS *	9140.35
REPARACIONES/INVERSIONES	9361.20
REINTEGROS MINECO	48428.72
INTERESES DEMORA	16598.34
	<b>132705.03</b>

## **3. RESEARCH ACTIVITIES (2018)**

- 1. Research Highlights**
- 2. Projects and Funding**
- 3. María de Maeztu Excellence Award**
- 4. Publications**
- 5. Scientific and Academic management**

**14 competitive projects and 6 transfer contracts with Administration and industry**

**230 publications in international journals of high impact**

**4.7 M€ obtained, including 2 M€ from the National Excellence Program**

**Over 150 outreach activities reaching more than 3000 students**



**EXCELENCIA  
MARÍA  
DE MAEZTU**

2018 - 2021

## **PARTICLE PHYSICS AND INSTRUMENTA- TION**

### **Research Highlights During 2018**

#### **Key figures 2018:**

9 Tenure researchers  
3 Tenure track  
4 Postdoc contracts  
7 Predoc contracts  
2 Technical contracts

9 Active projects  
(1 H2020)

160 Papers (top JCR  
journals)

6 Conferences and  
Workshops organized

1 PhD Thesis  
2 Master Theses  
3 Bachelor Theses

Active participation  
in the UIMP-UC  
Data Science and  
Physics of Particles

In December 2018 the Large Hadron Collider (LHC) successfully completed its Run2. During the period 2015-2018, the delivered luminosity to the ATLAS and CMS experiments reached  $160 \text{ fb}^{-1}$ , at a center of mass energy of 13 TeV in proton-proton collisions. CMS marked a record of publications this year, with 141 papers submitted to which the experimental PP&I group contributed significantly. Among the most relevant CMS physics achievements are those related to the coupling of the Higgs Boson to the third generation of quarks, in particular  $t\bar{t}H$ , and H decaying to  $b\bar{b}$  processes. Always in Higgs physics, our group had a leading contribution in the final observation by CMS of Higgs decaying to W pairs. Moving to physics Beyond the Standard Model (BSM), two analyses completed in 2018 (Phys. Rev. Lett. 122, 011803, and JHEP11(2018)079) are the subject of two PhD theses of IFCA students. “Search for dark matter produced in association with a top quark pair at  $\sqrt{s} = 13 \text{ TeV}$ ” (by Juan Garcia), and “Search for pair production of charginos and top squarks in final states with two oppositely charged leptons in pp collisions at  $\sqrt{s} = 13 \text{ TeV}$ ” (by Barbara Chazin, to be defended early 2019).

Members of the group are authors of two CERN Reports (CERN Yellow Reports) summarizing the potential reach and opportunities in Higgs physics (arXiv:1902.00134) and Beyond the SM Physics (arXiv:182.07831) during the High Luminosity phase of the LHC, with an expected dataset of pp collisions at 14 TeV, corresponding to an integrated luminosity of  $3 \text{ ab}^{-1}$ . The potential of an LHC upgrade, colliding protons at a centre of mass energy of 27 TeV and producing a dataset corresponding to an integrated luminosity of  $15 \text{ ab}^{-1}$ , is also considered in these studies.

The contribution of the group to data taking and detector oriented tasks is split in two fronts: detector operations, and upgrade activities. The former mainly concerns the Muon Detector Performance Group (DPG) and Physics Object Groups (POG), where we participate in a rich variety of tasks: Muon Alignment, Data Quality Monitoring, Certification and Validation of raw data, etc. Group members have been editors of two scientific papers: “Performance of the CMS muon detector and muon reconstruction with proton-proton collisions at  $\sqrt{s}=13 \text{ TeV}$ ” (JINST, Vol. 13, June 2018), and “The network of photodetectors and diode lasers of the CMS Link alignment system” (NIMA Vol. 896, p. 1-23).

The work to fulfill the upgrade commitments for the HL-LHC phase is ramping up quickly. Briefly, the main contributions in 2018 have been:

- Extreme radiation-tolerant pixel detectors for the HL-LHC upgrade of the CMS vertex detector and future hadronic colliders. The group is pursuing the development of pixelated Silicon sensors with vertical deep-etched junctions (named 3D pixel sensors). This year a major milestone was achieved by demonstrating the excellent radiation tolerance (up to  $1 \times 10^{16}$   $n_{\text{equ}}/\text{cm}^2$ ) of 3D sensors with a pixel cell aspect form of  $25 \times 100 \mu\text{m}^2$  with one single collecting electrode. This pixel cell geometry could be produced at the manufacturing foundries with relatively high yields; therefore, this is a chief result towards the qualification of the 3D technology for the innermost layer of the CMS Inner Tracker.
- Detectors for 4-Dimensional tracking. The PP&I group is contributing to the Endcap Timing Layer detector of CMS by developing a new kind of radiation-resistant avalanche diodes named Low Gain Avalanche Detectors (LGAD). The group has proposed an evolved version of this technology (iLGAD), which could enable a true 4-D tracking and vertex system with precise spatial and time determination of charged particles. In 2018, a first proof-of-concept of a iLGAD microstrip prototype was completed, demonstrating its timing and tracking capabilities.

IFCA hosts part of the CMS Spanish Tier-2 center. The main tasks during 2018 have been: a) the operation of the Tier-2, including its integration and synchronization with the CMS systems; b) maintenance and upgrade of the hardware. This year we upgraded the access storage system; and c) a centralized R&D for the commissioning of the new release of PHEDEX, and the development of a new system to run in external HPC (as ALTAMIRA). The work is done in coordination with the Computing and e-Science group.

This activity results in a significant presence of our group in the CMS scientific organization reflected in a series of responsibility positions in Physics Analysis Groups, PAGs, and other CMS committees: seven members in Level 3 (Inner Tracker, Muons, Certification, Validation, DQM, MC, SUSY), one member is part of the Conference Committee, and three more are members of various Publication Committees (DTs, TOP, and EXO). Moreover a member of the group has been elected as convener of the LHC Higgs Cross Section Working Group1 that coordinates the four big LHC experiments together with the theory contribution.

In addition to the specific CMS-oriented activities stated above, the group follows several generic instrumentation R&D activities in the context of the RD50 collaboration or the EU funded "Advanced European Infrastructures for Detectors at Accelerators", AIDA-

2020 project, where a member of the group is convener of the work package on "Advanced Hybrid pixel detectors".

One strong motivation to carry out this generic research is to ensure the presence of the group in the promising techniques expected to dominate the field in the next decade. Among them, the application of the Two-Photon-Absorption Transient Current Technique for the characterization of depleted CMOS and the development of a fiber femtosecond laser were major milestones in 2018. An initiative has been launched with the support of the CERN Knowledge Transfer Department.

The activity on new experimental facilities is channeled through the Spanish network of Future Accelerators, chaired by a member of our group.

Regarding non-accelerator based physics; the group is consolidating its presence in the DAMIC-M experiment. A new postdoc and a new master student have joined the IFCA group in DAMIC. The activity concentrates on: a) Data taking and Data Quality, b) Measurement of the radiopurity of new DAMIC-M components, using the Canfranc Underground Laboratory facilities, c) Development of data quality monitoring system (DQM system) for DAMIC and DAMIC-M, and d) Optimization of DAMIC-M design, using GEANT4, in terms of geometry and materials.

New initiatives started this year are collected in proposals submitted to different open calls, as:

1. Attract (H2020): TILGAD - Enabling high-resolution 4-dimensional radiation imaging. A collaboration of IFCA, XFEL-DESY, NIKHEF, USC
2. BBVA2018: Development of a toolbox for the application of Image Oriented Neural Networks to the processing of Particle Physics events. Reference: PR[18]\_DAT\_0113
3. EoI: Expression of Interest on behalf of the DAMIC Collaboration in the use of the facilities of the Canfranc Underground Laboratory (LSC) for the characterization of DAMIC components. Submitted in November 2018.

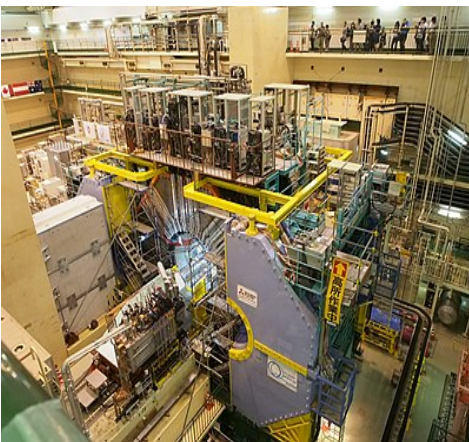
The activity of the **Phenomenology group** in 2018 concentrated mainly on the improvement of the analysis and theoretical calculations of Higgs processes and Supersymmetric models to be used at the LHC experiments, and study of the potential reach of these processes in new experimental facilities as: HL/HE-LHC, FCC-ee, etc.

The work has been developed in coordination with the corresponding working groups (LHCXSWG-Branching Ratios,

FCC-ee Precision Calculation, LHC and DM, etc.), and is reported in several scientific publications. There is a continuous and intense participation in conferences and workshops, including the co-organization of the following workshops: Precision Higgs Mass Calculation Workshop Series (KUTS), Higgs Days at Santander, and 2nd Workshop of the LHC network.

It is important to note that the only member of the group (Sven Heinemeyer) is in leave of absence, with a “Research Award” at the Madrid’s Instituto de Fisica Teorica (IFT).

## HIGHLIGHTS



**Fiber Optic Sensors (FOS) for the temperature monitoring of the Belle-2 vertex detector at KEK.** The PP&I group has completed the development and commissioning of ultra-low material, minimally invasive multipoint temperature and humidity monitoring system for the Belle-2 vertex detector. This system is based on the FBG optical sensing technology. Among several system aspects, the main effort of this activity was placed on the radiation-tolerance enhancement of the technology. The work is documented in “DEPFET pixel detector in the Belle II experiment” [[link](#)]



**CMS formally approved the installation of a new Mip Timing Detector (MTD) for the upgraded version of the detector foreseen for the HL-LHC phase.** The PP&I group expressed interest in R&D of high precision timing sensors (LGADs) to be implemented in the EndCap Timing Layer (ETL). Benchmark studies using long-lived signatures have been used to explore the potential of this proposal. The results of the studies will be reported in a dedicated CMS Technical Design Report.



**CERN launched the process for the Update of the European Strategy for Particle Physics 2018-2020.** This is an important discussion of the entire Particle Physics community that takes place every five years. The IFCA group has participated in the discussion process carried out at national level, and members of the group were selected as co-editors of the document submitted by the Spanish Particle Physics community.



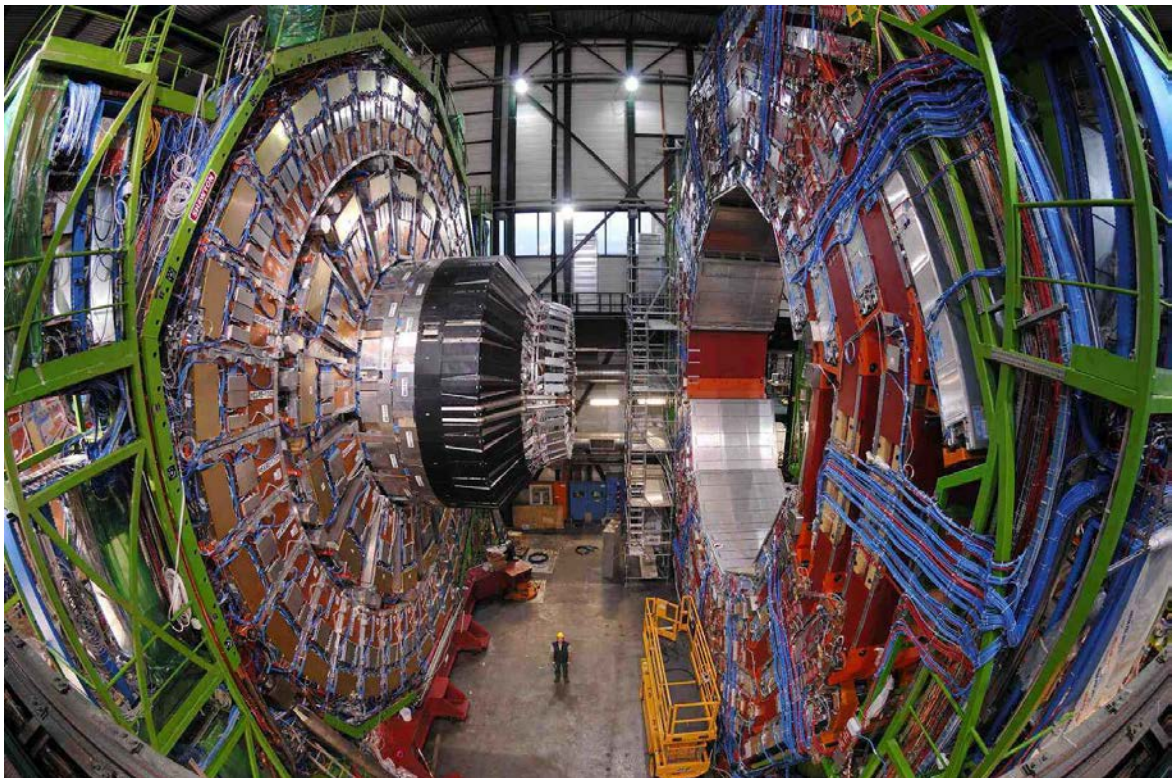
## SELECTED PUBLICATIONS

CMS Collaboration, Measurements of properties of the Higgs boson decaying to a W boson pair in pp collisions at  $\sqrt{s} = 13$  TeV. Phys. Lett. B, 791 (2019) 96.

CMS Collaboration, Combined measurements of Higgs boson couplings in proton-proton collisions at  $\sqrt{s} = 13$  TeV. CERN-EP-2018-263, Submitted to EJP.

E. Currás, J. Duarte-Campderrós, M. Fernández, A. García, G. Gómez, J. González, R. Jaramillo, D. Moya, I. Vila, S. Hidalgo, M. Manna, G. Pellegrini, D. Quirion, D. Pitzl, A. Ebrahimi, T. Rohe, S. Wiederkehr, First study of small-cell 3D Silicon Pixel Detectors for the High Luminosity LHC, arXiv:1806.01435, NIM: NIMA-D-18-01260

P. Martinez Ruiz-del Arbol, P. Gomez, C. Diez, A. Orio, Non-destructive testing of industrial equipment using muon radiography, Philosophical Transactions of the Royal Society A, 10 December 2018, <https://doi.org/10.1098/rsta.2018.0054>



## OBSERVATIONAL COSMOLOGY AND INSTRUMENTA- TION

### Research Highlights during 2018

#### Key figures 2018:

5 Tenure researchers  
7 Postdoc contracts  
4 Predoc contracts

8 active projects  
(1 H2020)

26 papers (top JCR  
journals)

1 Master Thesis  
5 Bachelor Theses

Active participation in  
the UC-UIMP Particle  
and Cosmos Physics  
(inc. direction)

The research activities of the Group during 2018 have focused on the **scientific analysis** of Planck and QUIJOTE data of the Cosmic Microwave Background (**CMB**) and of the Hubble Frontier Fields (**HFF**) images around selected rich clusters of galaxies; and on the development of a demonstrator for a **large-format polarimeter interferometer** with optical correlator and the study of a **calibration satellite** for future CMB polarization missions.

The group has contributed to the 2018 **Planck Legacy Release** and the accompanying 12 publications (10 in refereeing process and 2 to be submitted in the next weeks) that have confirmed the standard cosmological model with the highest precision to date and also the presence of some anomalies. The group has coordinated the isotropy and statistics paper and has made a major contribution to the diffuse component separation one; in addition, it led the Planck intermediate results paper on the multi-frequency catalogue of non-thermal sources. In 2018 the Planck team was awarded with the RAS Group Achievement, the Gruber Cosmology Prize and the Marcel Grossmann Award. In relation to **QUIJOTE** and the associated **Radioforegrounds** H2020 project, the group was in charge of the generation of the polarized diffuse components in the microwave domain combining QUIJOTE, Planck and other data, and was contributing to the commissioning and calibration of the TFGI instrument.

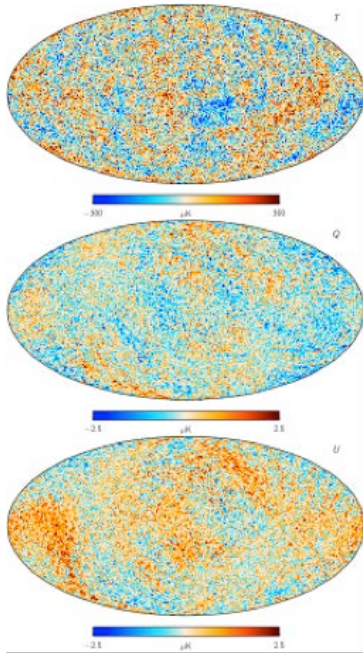
At the beginning of 2018 we joined the JAXA **LiteBIRD** space mission to measure the CMB B-mode polarization. This is the mission that is best placed worldwide and the European consortium is contributing with the medium-high frequency telescope (MHFT) and with the Data Center. Our group leads the Spanish contribution, where E. Martínez-González is a member of the LiteBIRD-Europe Steering Committee, and has proposed and studied a calibration satellite. The group is also well positioned in relation to the ground-based CMB experiments, participating in the future plans at the European level where E. Martínez-González is a member of the **ECMB** coordination committee.

Regarding instrumentation, recently the group has successfully developed a demonstrator of a large format microwave polarimeter interferometer with an **optical correlator** of interest for the next generation of ground-based CMB polarization experiments.

The group is also involved in several large-scale structure projects. In particular, J.M. Diego has been very much involved in the recent **HFF** results on microlensing effects and on the recent discovery of

a star at cosmic distances, published in two Nature Astronomy and one ApJ papers and also appearing in international press and media. Other experiments in which we are involved are JPAS, coordinating the Cluster of Galaxies working group, and at a lower level Euclid and SKA/ASKAP.

At the national level, the group has initiated the creation of a CSIC platform on microwave instrumentation for cosmological applications involving 10 groups from inside and outside CSIC.



### HIGHLIGHTS:

*Planck Legacy Release of a new and improved version of the data acquired by Planck, which constitutes the final official release from Planck. These data provides our strongest constraints on the parameters of the standard cosmological model and some of the tightest limits available on deviations from that model.*

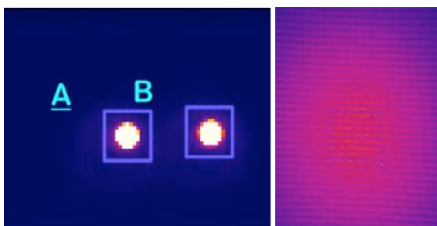
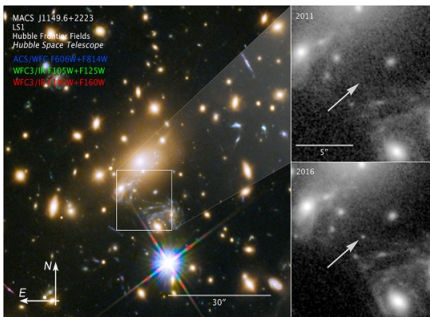
Our group coordinated the Isotropy and Statistics topic and produced the SEVEM CMB intensity and polarization maps shown in the accompanying figure, one of the four official maps of Planck.

*HFF results on microlensing effects and on the recent discovery of a star at cosmic distances. This star, MACS J1149 Lensed Star 1, also known as Icarus, is of the type of a blue supergiant observed through a gravitational lens. It is the most distance individual star detected, at approx.  $z=1.49$  or 14.4 billion light years commoving distance.*

The group contribution to this and other related findings was mainly in the full description of the role of microlenses in caustic regions, and constraints on primordial black holes with masses comparable to those found by LIGO.

*Microwave polarimeter interferometer with an optical correlator.*

During 2018 a 10-20 GHz polarimeter demonstrator has been developed and tested in the lab. Polar measurements have been performed, showing promising results for both direct imaging and synthesized imaging interferometric applications.



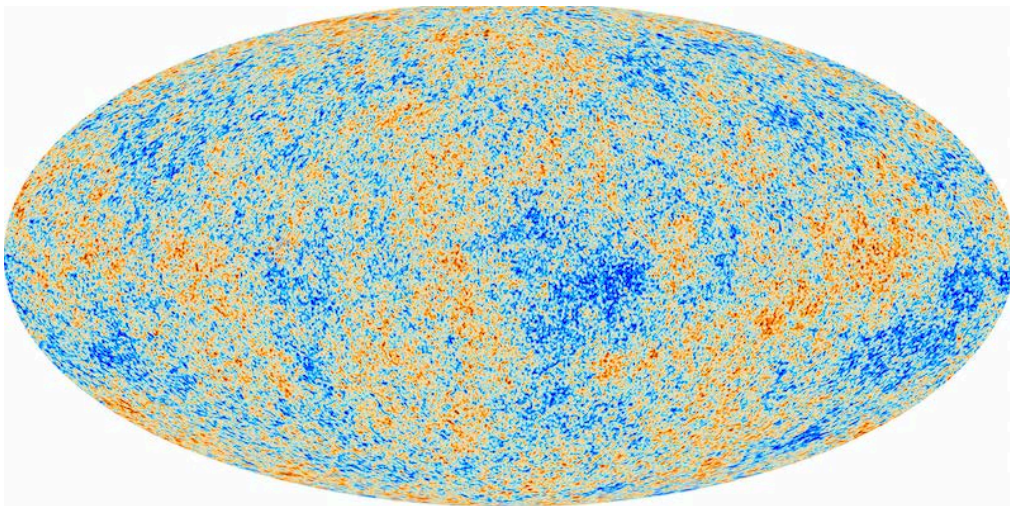
## SELECTED PUBLICATIONS

"Planck 2018 results. IV. Diffuse component separation", Planck Collaboration (including: R.B. Barreiro, B. Casaponsa, J.M. Diego, D. Herranz, R. Fernández-Cobos, A. Marcos-Caballero, E. Martínez-González, P. Vielva), A&A, accepted (arxiv:1807.06208)

"Extreme magnification of an individual star at redshift 1.5 by a galaxy-cluster lens", P.L. Hellu, J.M. Diego, S. Rodney, et al., 2018, Nature Astronomy, 2, 334

"Exploring cosmic origins with CORE: The instrument", CORE Collaboration (including: F. Casas, R. Fernández-Cobos, E. Martínez-González, P. Vielva), 2018, JCAP, 4, 15

"Planck intermediate results. LIV. The Planck multi-frequency catalogue of non-thermal sources", Planck Collaboration (including: R.B. Barreiro, B. Casaponsa, J.M. Diego, D. Herranz, R. Fernández-Cobos, A. Marcos-Caballero, E. Martínez-González, P. Vielva), A&A, 2018, 619, A94



## GALAXIES AND AGNs

### Research Highlights during 2018

#### Key figures 2018:

4 Tenure researchers

1 Tenure track

6 Postdoc contracts  
(one part-time)

5 Active projects

10 papers (top JCR journals)

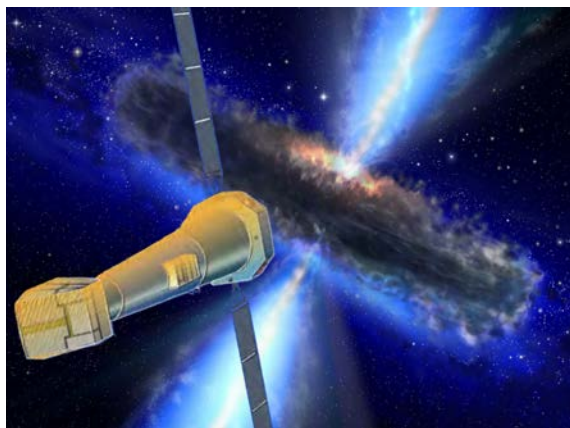
Active participation in the UIMP-UC Physics of Particles and the Cosmos Master.

During 2018, important advances have been made in several projects in which the group of Galaxies and AGN of the IFCA participates:

- The analysis of the [ALHAMBRA](#) Survey data is ongoing. The data are being used by the team to measure many different aspects of galaxy formation and evolution
- The first square degree of the intermediate band wide area survey [J-PAS](#) has been concluded and catalogues have been produced
- [OTELO](#) (the census of galaxies with the deepest emission lines to date) has been completed and the data will be published soon
- Within the [Athena project](#), the phase A1 has been completed with “Status Review 1” in October 2018, the Instrument Preliminary Review (IPRR) of the WFI instrument has been passed in October 2018 and an onboard processing baseline has been established for the IPRR of the X-IFU (expected for February 2019) and the instruments consortia have been officially accepted by ESA in December 2018
- The *Athena* Community Office (ACO), led by IFCA, supports the *Athena* Science Study Team in managing the 800-strong *Athena* Community and has participated in the *Athena*-SKA (finished) and multi-messenger (started) synergy exercises and it manages the *Athena* Mock Observation Plan.

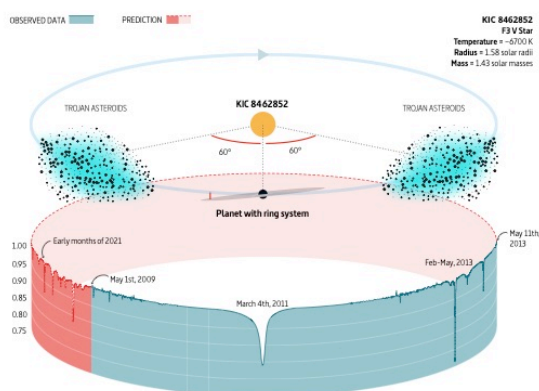
In addition, the group is increasingly involved in applying Machine Learning techniques to Astronomy, with a new postdoc (expert in classification algorithms) hired and collaborations started with with the Instituto de Inteligencia Artificial de Barcelona (Spain, to apply machine learning techniques to the detection and characterization of X-ray pulses in X-IFU detector on board *Athena*) and with MPE (Germany, to select and characterise multiwavelength counterparts to X-ray sources). As part of these efforts the group has encouraged and led setting an IFCA-wide working group on Machine Learning techniques.

The group persistently participates in all the outreach activities of IFCA, even leading some of them, such as two astronomical observations performed from the IFCA premises and those organised by the ACO. Furthermore, the directorship of [Astronomical Observatory of Cantabria](#) is being held by a member of the group.



## HIGHLIGHTS

**Phase A1 of the *Athena* project** was completed in October 2018, the two instrument consortia were officially accepted by ESA in December 2018 and the IPRR of one of them (WFI) was successfully passed in October 2018. *Athena* is on track for its Mission Formulation Review in the third quarter of 2019, adoption in 2021 and launch in the early 2030s



**KIC 8462852**, also known as "Tabby's Star" is probably the most strange star ever observed. During the years that the Kepler satellite observed it there was a major dimming (similar to what a crossing planet would have caused, but much larger than any previously observed), and there were two different periods of strong, highly irregular variability. In this paper our group suggests that the major dimming could have been caused by a very large, ringed planet,

whereas the irregular periods could be produced by Trojan asteroids associated to its orbit. We predict the onset of a new phase of irregular variability in 2021, and the next passage of the large planet in 2023. This paper attracted a lot of media attention, thus being classified at the top of the "AltMetric" rating for several weeks after its publication, and it remains within the top 5% articles in its scale.

## SELECTED PUBLICATIONS

Ballesteros, F.J.; Arnalte-Mur, P.; Fernandez-Soto, A.; Martínez, V.J. 2018, "KIC 8462852: Will the Trojans return in 2021?" *Monthly Notices of the Royal Astronomical Society*, 473, L21-L25

Tuccillo, D., M. Huertas-Company, E. Decencièrre, S. Velasco-Forero, H. Domínguez Sánchez, & P. Dimauro, 2018, "Deep learning for galaxy surface brightness profile fitting". *Monthly Notices of the Royal Astronomical Society*, 475, 894-909

Barret, D., T. Lam Trong, J.-W. den Herder, L. Piro, et al., 2018, "The ATHENA X-ray Integral Field Unit (X-IFU)", *Proceedings Space Telescopes and Instrumentation 2018: Ultraviolet to Gamma Ray*, 10699, 106991G

Ruiz, A., A. Corral, G. Mountrichas, & I. Georgantopoulos, 2018, "XMMPZCAT: A catalogue of photometric redshifts for X-ray sources". *Astronomy and Astrophysics*, 618, A52

## NONLINEAR DYNAMICS

### Research Highlights during 2018

#### Key figures 2018:

4 Tenure researchers  
2 Predoc contracts

4 Active projects

12 papers (9 top JCR journals, 2 in the 1<sup>st</sup> decile)

The research activities of the Group during 2018 have focused on the implementation of the projects COMBINA and VASCOSCAD. In the Photonics subline our research has focused on the analysis of optical frequency comb generation and characterization in gain-switched semiconductor lasers and vertical-cavity surface-emitting lasers. Frequency combs have attracted enormous technological interest lately due to its applications in optical communications, spectroscopy, microwave photonics and LIDAR systems, among many other examples. These activities have been carried out in the context of the project COMBINA (Spanish Research Program) in collaboration with the Univ. Politécnica and Carlos III (Madrid) and the industrial partner Luzwavelabs. The research results have been published in top journals and conference papers in the area of photonics. Our paper on “*1/f noise in the intensity fluctuations of vertical-cavity surface-emitting lasers subject to parallel optical injection*” is to be highlighted as it provides the first experimental example of long-temporal correlations in these type of lasers, due to a power-law distribution in the time separation between pulses observed in the time residence series.

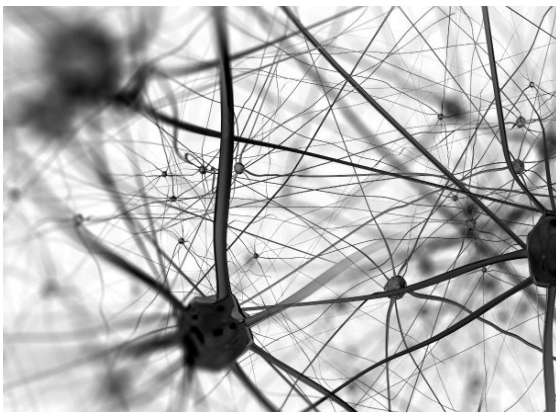
The Nonequilibrium Statistical Physics and Chaos section of the group has continued its research activity in the context of the ongoing project VASCOSCAD (Spanish Research Program) which aim is to investigate variability and reliability in high-dimensional chaotic systems (spatially extended as well as networked systems, like population of neurons). The project has hired two PhD students in 2018.

During 2018 we have also started a project to investigate the effects of long-termed correlated noise in stochastic surface growth. This is a two-year project funded by the CSIC program for international cooperation, I-COOP. The project is led by our group and involves researchers from CONICET (Argentina).

#### HIGHLIGHTS:

Publication of the paper “Kuramoto Model for Excitation-Inhibition-Based Oscillations”, in *Physical Review Letters* 120, 244101 (2018)

Derivation of a two-population Kuramoto model that fully accounts for the onset of excitation-inhibition-based neuronal rhythms observed in experiments, which we expect will provide a powerful theoretical tool for the analysis of large-scale neuronal oscillations.

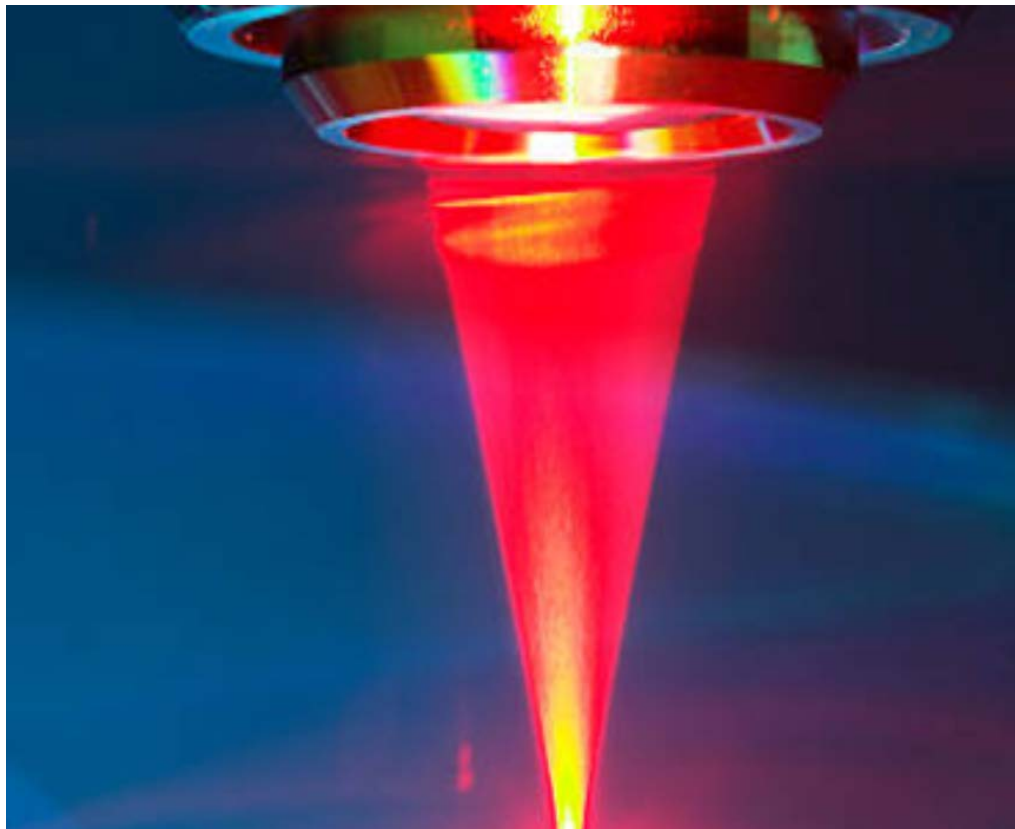
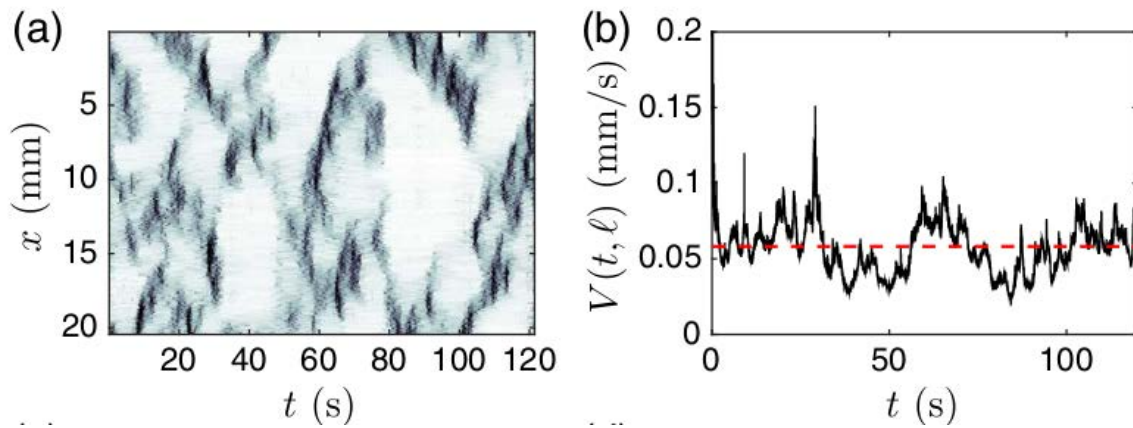


## SELECTED PUBLICATIONS

E. Montbrió and D. Pazó (2018) Kuramoto Model for Excitation-Inhibition-Based Oscillations. *Phys. Rev. Lett.* 120, 244101. DOI: [doi.org/10.1103/PhysRevLett.120.244101](https://doi.org/10.1103/PhysRevLett.120.244101)

R. Planet, J.M. López, S. Santucci, and J. Ortín (2018) Spatiotemporal Organization of Correlated Local Activity within Global Avalanches in Slowly Driven Interfaces. *Phys. Rev. Lett.* 121, 034101. DOI: [doi.org/10.1103/PhysRevLett.121.034101](https://doi.org/10.1103/PhysRevLett.121.034101)

M.A. Rodríguez, F.D. Coarer, and A. Valle (2018)  $1/f$  noise in the intensity fluctuations of vertical-cavity surface-emitting lasers subject to parallel optical injection. *Phys. Rev. E* 97, 042105 – Published 6 April 2018. DOI: [doi.org/10.1103/PhysRevE.97.042105](https://doi.org/10.1103/PhysRevE.97.042105)





## ADVANCED COMPUTING

### Research Highlights during 2018

#### Key figures 2018:

3 Tenure researchers

5 Postdoc contracts

5 Predoc contracts

4 H2020 active  
projects

8 papers (top JCR  
journals)

>20 conference  
proceedings

5 Master Theses

Active participation in  
the UIMP-UC Data  
Science master  
(academic  
coordination).

The research activities of the **Advanced Computing and E-Science** Group during 2018 have centered on the design, development and implementation of distributed compute infrastructures focused on emerging intensive computing techniques, such as deep learning, and the design and support of tools that enable the whole data management cycle for research. In this regard the group is coordinating the DEEP-Hybrid-DataCloud H2020 project and it is actively participating in the eXtreme-DataCloud project, both involving more than 10 international partners. The outcomes of these projects (among others) will enable researchers with a broader set of tools and services in the context of the European Open Science Cloud (EOSC). Moreover, the group holds the **academic coordination of the Data Science Master** (joint official master UIMP-UC) and has opened a new research line, focusing on the application of deep learning techniques to different knowledge domains, such as artificial vision, earth observation or remote sensing. In this regard we have established a close collaboration with the Meteorology and Data Mining group.

More specifically, during 2018 the Group is participating in four different EU **projects under the H2020 framework program**:

- DEEP-Hybrid-DataCloud: Designing intensive data processing services in hybrid clouds (**project coordinator**).
- eXtreme-DataCloud: Scalable data management technologies in distributed environments (deputy coordination, workpackage leader).
- EOSC-Hub: Single contact point for the EOSC.
- AARC2: Authentication and Authorization for Research collaborations

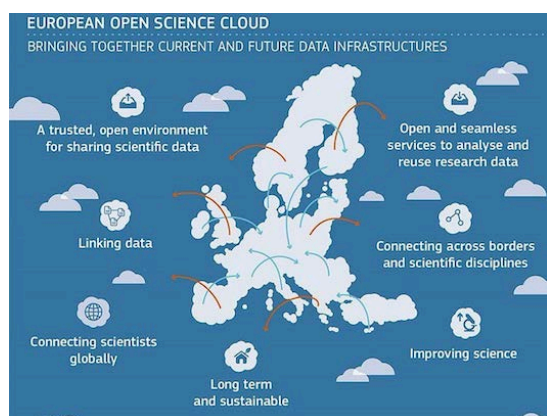
In addition, the group has been granted other competitive projects or research transfer contracts, such as:

- “Diagnosis and characterization of Non-Alcoholic Fatty Liver Disease based on Artificial Intelligence” funded by Gilead Sciences.
- “Native OpenID Connect Implementation for OpenStack Clouds” funded by EGI.eu Strategic and Innovation Fund.
- “Elastic Serverless Platform for High Throughput Computing Scientific Applications” funded by EGI.eu Strategic and Innovation Fund.
- “3-dimensional modelling of Sanabria Lake” in collaboration with Ecohydros SL.

The group is also an active promoter of **Open Science** and **Open Software**. In this regard, the software collection of the group is completely available in open and publicly accessible repositories under an open source license, as well as through the DIGITAL.CSIC institutional repository (as a matter of fact, the group's software collection was the first being archived).

On the technical side the group operates a medium size data and computing center, comprising a **Cloud infrastructure** (part of EGI.eu Federated Cloud), a **High Throughput Computing (HTC)** node (part of EGI.eu HTC) and a **High Performance Computing (HPC)** node (part of the Spanish Supercomputing Network), with more than 2PB of online data. This infrastructure is instrumental for IFCA, and thanks to its existence the institute has continued its participation in relevant distributed computing initiatives, both at the national and international level. In this regard, the IFCA Cloud Infrastructure is the largest contributor to the EGI.eu Federated Cloud, both in terms of computing resources and delivered CPU hours to the different EGI.eu scientific communities.

The international presence of the group is complemented by the direct participation of relevant fora, such as the INDIGO-DataCloud collaboration, the Open Research Cloud Alliance (ORCA), the EU Cloud Stakeholder Working Group or the CERN Open Science and Analysis Preservation Groups.



The research activities of the **Distributed Computing and Grids** Group during 2018 have been developed in the framework of the RC\* and the European Open Science Cloud (EOSC) initiatives.

The launching of the European Open Science Cloud (EOSC) and related projects and initiatives has also marked the activity of the group during 2018. The European Commission vision for EOSC is a fundamental part of the Digital Single Market Strategy. The objective of the EOSC is to give the

Union a global lead in research data management and ensure that European scientists reap the full benefits of data-driven science. The group has been involved in a number of activities:

1. Simplify access to a broad portfolio of products, resources and services provided by the major pan-European and international organisations through an open and integrated service catalogue.
2. Remove fragmentation of service provisioning and access to high-quality digital services in Europe and beyond through the

technical integration and adoption of standards for interoperability of compute, storage, data and software.

3. Consolidate e-Infrastructures by expanding capacity and capabilities and improving service quality.
4. Increase the innovation capacity of our research e-infrastructures.

The Lattice QCD activity is known to require intensive computing resources. Relevant achievements have been obtained in 2018 with the participation of this group in the framework of the RC\* Collaboration (<http://rcstar.web.cern.ch>) to provide a highly scalable simulation code for Wilson fermions with C\* boundary conditions and to address questions regarding tuning of physical & algorithmic parameters, O(a)-improvement & renormalization, and so on. One of the 2018 highlights is the release of the *OpenQXD Software* available at <https://digital.csic.es/handle/10261/173334>.

### HIGHLIGHTS:



Release of the first software platform of the DEEP-Hybrid-DataCloud project, aiming at delivering a distributed computing infrastructure focused on deep learning and machine learning for scientists, allowing reuse of existing tools and models, as well as Service Oriented Architectures.

The Advanced Computing group has strengthened its collaboration with other IFCA groups, providing scientific computing and technical support, consolidating its position as a transversal activity within the institute.



Publication of the European Commission EOSC HLEG final report (with the participation of Isabel Campos) to advise the European Commission on the measures needed to implement the European Open Science Cloud containing 32 pragmatic recommendations.

### SELECTED PUBLICATIONS:

L. Lloret et al. (24 coauthors) (2018) “Open is not enough”. *Nature Physics* 15, 113–119. DOI: 10.1038/s41567-018-0342-2.

Á. López García, E. Fernández, and I. Campos (2018) “An efficient cloud scheduler design supporting preemptible instances”. In: *Future Generation Computer Systems* 95 (2019), pp. 68–78. ISSN: 0167-739X. DOI: 10.1016/j.future.2018.12.057.

I. Campos, J. Marco de Lucas, A. López-García, P. Orviz, F. Aguilar, L. Lloret, et al. (2018) INDIGO-DataCloud: a Platform to Facilitate Seamless Access to E-Infrastructures. *Journal of Grid Computing*, 8 2018, DOI: 10.1007/s10723-018-9453-3.

## METEOROLOGY AND DATA MINING

### Research Highlights during 2018

#### Key figures 2018:

2 Tenure researchers  
1 Postdoc contracts  
4 Predoc contracts

6 active projects  
(1 new H2020)

14 papers (top JCR  
journals)

1 Conference  
organized

2 Master Theses

Active participation in  
the UIMP-UC Data  
Science master  
(inc. direction).

The research activities of the Group during 2018 have focused on the analysis and downscaling of regional climate information, contributing to the development of climate services. During this period the group has contributed to **two special issues** of two ended projects (EUPORIAS, EU FP7; VALUE EU Cost action) where the group has led 5 publications (in the journals *Climate Services* and *International Journal of Climatology*). These two special issues provide state-of-the art practices of climate data postprocessing (e.g. bias correction and downscaling) in the context of **seasonal forecasting** and **climate change projections**, respectively, and are expected to have a high impact in the community. Moreover, the Group has started a new research topic focusing on the application of **machine learning** (in particular deep learning and Bayesian networks) to downscaling, obtaining encouraging results presented in two machine learning in climate conferences (two papers have been submitted).

During 2018 the Group participated in three competitive projects:

- MULTI-SDM: Multivariate statistical downscaling methods (from the **National Research Program**).
- Africultures: Climate services for Africa (**Horizon 2020**).
- INDECIS: Sectorial climate services (ERA for Climate Services, **ERA4CS**).

and in three research transfer contracts with industry and administration:

- “Climate risk analysis and visualization platform for adaptation and disaster risk reduction in agriculture – climate component” funded by **FAO/ONU**.
- “Quality control for seasonal forecast products”, funded by the **COPERNICUS** program (subcontracted by BSC).
- “New functionalities of the scenarios portal for the National Adaptation Plan”, funded by Fundación Biodiversidad (Ministry of Ecological Transition, **Spanish Government**).

During 2018 the Group has strengthen its **international collaborations** thanks to the appointment of José M. Gutiérrez as member of the Science Advisory Team (SAT) of the **CORDEX** initiative, a core activity of the World Climate Research Program (WCRP) for climate change regionalization. Moreover, the group has also an important role for the AR6 **IPCC** report, being responsible of the development and deployment of the Interactive Atlas, a new tool in AR6 summarizing the key results and providing extended online interactive analysis via a Web platform.

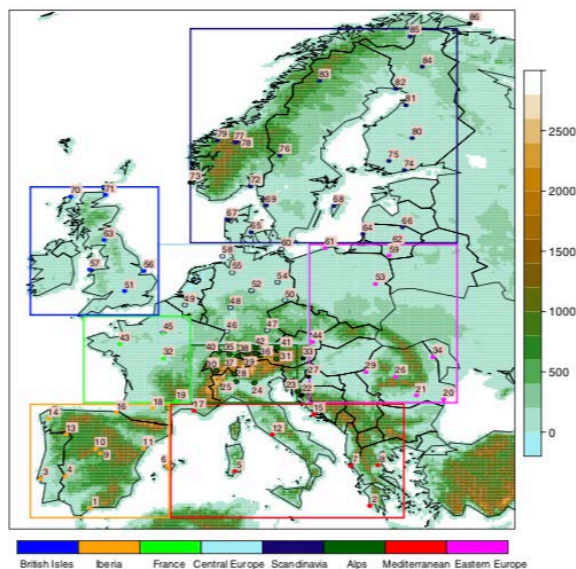
These activities have consolidated the role of IFCA at a national level, leading a CSIC platform formed by 5 institutes for the development of climate services (building on the experience acquired in COPERNICUS and the forthcoming IPCC activities), which is one of the ten national platforms approved so far.

### HIGHLIGHTS:

*Publication of the IJOC special issue of the VALUE project (in press) with the most comprehensive to date intercomparison of statistical downscaling techniques over Europe, focusing on the temporal structure, extremes, spatial consistency, process representation, etc. (10 papers, 8 with IFCA contribution; in press).*

IFCA was part of the SC (steering committee) of the VALUE COST action and was responsible for the technical coordination of the first intercomparison experiment, with participation of over 50 methods from 27 institutions.

*IFCA will coordinate a new product of the AR6 report of the Intergovernmental Panel on Climate Change (IPCC), the Interactive Atlas, which will play a central role extending and summarizing the key results. This product will be supported by IFCA computing facilities, with the collaboration of the Group in Advanced Computing.*



### SELECTED PUBLICATIONS:

Gutiérrez, J.M. et al. (and 35 co-authors from the VALUE collaboration) 2018. An intercomparison of a large ensemble of statistical downscaling methods over Europe: Results from the VALUE perfect predictor cross-validation experiment. *International Journal on Climatology*. DOI: 10.1002/joc.5462 (12 citations, scopus).

Manzanas, R., Gutiérrez, J.M. et al. (2018) Dynamical and statistical downscaling of seasonal temperature forecasts in Europe: Added value for user applications. *Climate Services*. DOI: 10.1016/j.cliser.2017.06.004 (11 citations, scopus).

Manzanas, R., Lucero, A., Weisheimer, A., Gutiérrez, J.M. (2018) Can bias correction and statistical downscaling methods improve the skill of seasonal precipitation forecasts?. *Climate Dynamics*, 50(3-4), pp. 1161-1176. DOI: 10.1007/s00382-017-3668-z (9 citations, scopus).

## 2. PROJECTS AND FUNDING

The list of new projects starting in 2018 is given below, including the type of project (R: research; I: infrastructure). Note that a total of 4.7 M€ have been obtained in competitive calls during this year, including the 2 M€ grant from the Centers of Excellence María de Maeztu.

TY	TITLE	FR.	TO	IP	€	CODE
R	VIABILIDAD DE UN SATELITE DE CALIBRACION PARA MISIONES CIENTIFICAS ESPACIALES DE POLARIZACION DEL FONDO COSMICO DE MICROONDAS	11/2018	10/2019	BARREIRO, RITA B.	30250 €	ESP2017-92135-EXP
R	INSTRUMENTACION FOTONICA Y CALIBRACION DE KIDS PARA LA OBSERVACION DEL CMB. COSMOLOGIA DE FRONTERA CON DATOS DEL CMB Y LA LSS.	01/2018	12/2019	MARTINEZ, ENRIQUE	235950 €	ESP2017-83921-C2-1-R
R	APOYO A UNIDADES DE EXCELENCIA MARÍA DE MAEZTU	07/2018	06/2022	MARTINEZ, ENRIQUE	2000000 €	MDM-2017-0765
R	PARTICIPACION EN EL EXPERIMENTO CMS DEL LHC: RUN2 Y PIXEL UPGRADE PARA ALTA LUMINOSIDAD	01/2018	12/2020	GOMEZ, GERVASIO	1110780 €	FPA2017-85155-C4-1-R
R	RED PARA EXPLORAR LA FÍSICA DE INFLACIÓN	07/2018	06/2020	MARTINEZ, ENRIQUE	18500 €	AYA2017-90675-REDC
I	LASER INFRARROJO DE FIBRA DE FEMTOSEGUNDO PARA CARACTERIZACIÓN DE DISPOSITIVOS SEMICONDUCTORES	01/2018	12/2019	VILA, IVAN	107602 €	EQC2018-004529-P
I	AMPLIACIÓN DEL SERVICIO DE DATOS CLIMÁTICOS (SDC) PARA DAR SOPORTE A LAS ACTIVIDADES DEL IPCC-ATLAS	01/2018	12/2019	GUTIERREZ, JOSE M.	155027 €	EQC2018-004769-P
R	PARTICIPACION EN EL EXPERIMENTO CMS DEL LHC: RUN 2	01/2018	12/2020	MARTINEZ, CELSO	502150 €	FPA2017-85155-C4-4-R
R	IFCA: ACCIONES DE MEJORA CIENTÍFICA, TRANSFERENCIA DE TECNOLOGÍA Y DIFUSIÓN DEL CONOCIMIENTO 2018	12/2018	12/2019	RODRIGO, TERESA	39776 €	TF18-II-004
R	CORRECCIÓN DE SESGOS Y NUEVAS FUNCIONALIDADES PARA LA HERRAMIENTA DE ESCENARIOS DE CAMBIO CLIMÁTICO ADAPTECCA	09/2018	05/2019	GUTIERREZ, JOSE M.	29036 €	CA_CC_2017
I	MAQUINA DE MICROSOLDADURA (WEDGE BONDING)	01/2018	12/2019	RODRIGO, TERESA	101950 €	EQC2018-004718-P
R	EVOLUCIÓN DE GALAXIAS:CUÁSARES	09/2018	08/2019	GONZALEZ, JOSE I.	28483 €	JU25
R	CRECIMIENTO DE PELÍCULAS DELGADAS Y SUPERFICIES EN MEDIOS DESORDENADOS FUERTEMENTE CORRELACIONADOS	01/2018	12/2019	LOPEZ, JUAN M.	20000 €	COOPA20187
R	INTEGRATING AND MANAGING SERVICES FOR THE EUROPEAN OPEN SCIENCE CLOUD	01/2018	12/2020	CAMPOS, ISABEL	341781 €	H2020
					4721284 €	

### 3. MARÍA DE MAEZTU EXCELLENCE AWARD



Our institute was accredited as an outstanding research unit in the 2017 call of the programme “Maria de Maeztu Units of Excellence” (run by the Spanish Ministry

of Science, Innovation and Universities). This Award is granted for a period of 4 years (renewable), and it is funded with a total of 2M Euros, and the access to dedicated funding calls both for human resources and infrastructure support.

The “Center of Excellence Severo Ochoa” and “Unit of Excellence Maria de Maeztu” award ([web](#)) is an initiative within the State Plan for Scientific and Technical Research and Innovation, to fund and distinguished public research centers/units that demonstrate scientific leadership and impact at global level. The Centers of Excellence are organizational structures with highly competitive strategic research programmes in the frontiers of knowledge. An independent international committee of prestigious scientists with high impact carries out the evaluation and selection process.

The experts of the “Mathematics, Experimental Sciences and Engineering” area positively evaluated our unit (final resolution issued in November 2018). As reported by the committee on its consensus report:

Comments from the Evaluation Report

*“The top 10 scientific contributions indicate a high level of productivity, international leadership, and scientific impact across all of the research lines at IFCA. Clearly, there is excellent overall quality, not just a few individual or group-specific stellar contributions”.*

The assessment also stresses the internationalization of the scientific activity as well as the in-house available infrastructure:

*“A large fraction of the research activity is centered on large and unique international research infrastructure. Almost by default such facilities are appropriate to IFCA's activities and foster its international competitiveness...The unit also hosts, operates and benefits from computing infrastructure, grid and cloud resources, which enable IFCA to exploit large data sets in international frontier projects.”*

The strategic research project submitted to this program builds on the achievements acquired by the institute in its more of 20 years of existence. IFCA has managed to consolidate solid and well-established research groups working in frontier physics lines and it

treasures today a powerful combination of theoretical and experimental/observational research capability on basic science. We are now moving into a new phase where we need to position and maintain scientific excellence for the next decade.

Our **vision** for the next decade is to make IFCA a consolidated unit of international standards developing top class basic research in physics, gaining world class positioning through leadership in frontier research projects, and a reference centre in those subjects where multidisciplinary is key for the advancement of knowledge.

## RESEARCH PROGRAM

Based on a careful analysis of strengths and opportunities, we aim to complement effectively the existing research lines, and to increase their impact exploiting their synergies. The research program is structured in four Action Lines:

- 1) Positioning,
- 2) Synergies,
- 3) Communication and Outreach, and
- 4) Coordination, Management and Vision.

## POSITIONING

We have selected five international initiatives led by IFCA researchers with an excellence partnership, and decided to plan an Action line for POSITIONING them supporting their activity through co-funding the required additional resources:

- The ATHENA (Advanced Telescope for High Energy Astrophysics) project. In 2014 ESA selected Athena, a new generation X-ray observatory, as its next large science mission due for launch in 2028.
- The High Luminosity phase of the Large Hadron Collider (HL-LHC) AT CERN. The upgrade of the accelerator and detectors, in particular the CMS detector. This initiative, foreseen to be fully committed by 2026, was approved by CERN Council in 2016 and integrated in the EU ESFRI roadmap, it is already in an intensive R&D phase.
- The POL-CMB (polarisation of the Cosmic Microwave Background) project, for probing cosmic origins through a high sensitivity survey of the microwave polarization. It will be done with the next generation of ground-based experiments including QUIJOTE and space-based post-Planck initiatives like LiteBIRD (JAXA) or CORE (ESA/ISRO).
- Two international initiatives led by the research lines on advanced computing and on data mining, connected to the European Open Science Cloud (EOSC) and to CORDEX, the coordinated regional climate downscaling experiment, in relation to the Climate Change Service of COPERNICUS, the EU flagship programme on monitoring the Earth environment.



## SYNERGIES

SYNERGIES profits from the IFCA unique composition of research groups, is to support the exploration of multidisciplinary challenges exploiting the synergies among research lines. Two initiatives are launched, around the “Nature of the Hidden Constituents of the Universe” and the development of “Data Science frameworks to address Big Data problems in Open Science”. Different research lines are already collaborating in activities like the joint organization of specific workshops, or the organization of two new official masters in these areas, both coordinated by IFCA under the umbrella of CSIC/UIMP and UC.

COMMUNICATION  
AND OUTREACH

COMMUNICATION and OUTREACH addresses the need to strengthen the visibility of the institute and the relationship with society to secure the necessary support for a successful completion of our vision. Embedding science in the everyday culture and enlarging societal awareness are key components of our Outreach activities.

COORDINATION,  
MANAGEMENT  
AND VISION

To assure the coherence of the whole project we included the four Action Line integrating COORDINATION activities, MANAGEMENT, and VISION, aiming to reinforce the current administrative support, and also track and report project activities. A reinforced management structure will assure a global view of

Attendants to the public presentation of the María de Maeztu program, including Rosa Menéndez (CSIC president), Ángel Pazos (Universidad de Cantabria Rector), Xavier Barcons (European Southern Observatory ESO director –IFCA member–), and Eva Díaz Tezanos / Miguel Angel Revilla (vice-president / president of Cantabria Government).

project activities, assuring that the research strategy being implemented is correct, tracking new ideas and proposals, promoting new initiatives, and also involving IFCA External Advisory Board.



## 4. PUBLICATIONS

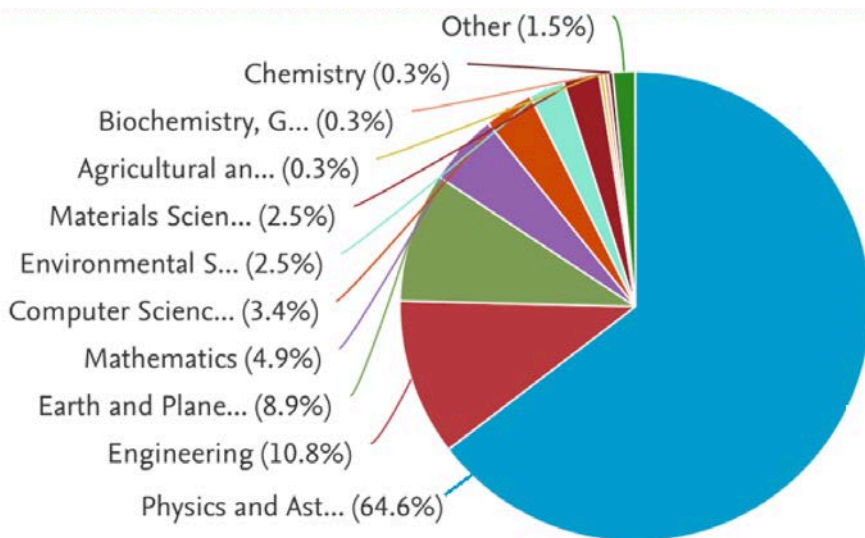
IFCA produces 220 publications per year on average (last five years, 2014-2018) in impact journals. Approximately 60% of these publications are the results of large collaborations, especially in the areas of particle physics and astrophysics. More than 90% of the papers are published in first quartile journals (10% in first decile). The h-index of the last five years is 73 and the top-5 most cited papers correspond to the Planck and CMS collaborations, with three papers over 2000 citations in this period.

Number of papers published in JCR journals, percentage in large collaborations, citations to IFCA papers during the year, and percentage of first quartile(Q1)/decile(D1) publications.

	2014	2015	2016	2017	2018	Mean
<b>Papers JCR</b>	219	212	240	201	<b>230</b>	220
<b>Large col. (%)</b>	56%	53%	67%	62%	<b>70%</b>	62%
<b>Citations (*)</b>	8744	9904	9537	9070	<b>9957</b>	9442
<b>Q1 (%)</b>	92%	95%	94%	90%	<b>92%</b>	92%
<b>D1 (%)</b>	11%	10%	5%	13%	<b>11%</b>	9%

(\*) Citations correspond to the number of citations in one particular year to the papers published in the previous 5-year period: 2014-2018 for 2018 citations 2013-2017 for 2017 citations etc.

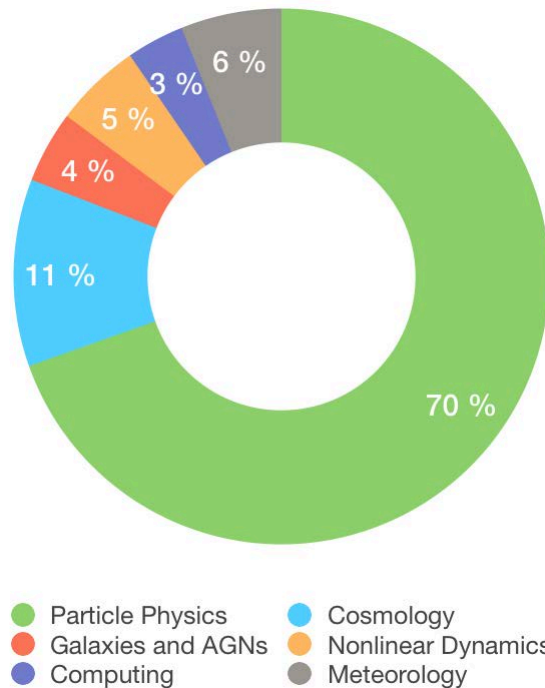
In 2018 the numbers of scientific articles published by IFCA in specialised journals is 230. About 70% in this period correspond to large collaborations (as CMS or Planck Collaborations), 92% are in the first quartile and 11% in the first decile (including one in Nature Physics and two in two in Nature Astronomy ). 74% of the papers are published in open access. The distribution of papers in different disciplines as well as the top-10 journals according to the number of published papers in 2018 are listed in the pie chart and table below.



Journal	#
Journal of High Energy Physics	60
European Physical Journal C	25
Physical Review Letters	24
Physics Letters Section B	24
Physical Review D	20
Journal of Cosmology and Astroparticle Physics	10
Astronomy and Astrophysics	5
Journal of Instrumentation	5
Climate Services	4
Proceedings of the SPIE	4

The distribution and analysis of papers by research lines is shown below.

Percentage of the total papers (230) contributed by each research line.



**Particle physics and Instrumentation:** The group has a total of 160 publications, most of them correspond to the CMS Collaboration (141), 96% are in the first quartile and 12% in the first decile.

**Observational Cosmology and Instrumentation:** The group has a total of 26 publications, 13 of them from large collaborations (50%), 96% are in the first quartile and 4% in the first decile. (notice that the 2 publications in Nature Astronomy are not considered since its impact factor is not available).

**Galaxies and AGNs:** The group has a total of 10 publications, 80% are in the first quartile.

**Nonlinear Dynamics:** The group has a total of 12 publications, all of them correspond to publications with small number of authors (from 3 to 7 authors), 73% are in the first quartile and 18% in the first decile.

**Advanced Computing:** The groups of this research line have a total of 8 publications, all of them correspond to publications with small number of authors; 84% are in the first quartile and 33% in the first decile.

It is worth noticing here, there is a relevant contribution to software development. The research line of advanced computing is committed to promote high standards in Software Quality and openness. Therefore its piloting with Digital.CSIC the institutional open software repository. More information at: [http://digital.csic.es/bitstream/10261/174617/3/DC\\_CA\\_18.pdf](http://digital.csic.es/bitstream/10261/174617/3/DC_CA_18.pdf)  
The software repository of the computing group can be found here: <https://digital.csic.es/handle/10261/173096>.

Moreover, members of the Distributed Computing Grid have contribute to the software product “Open Q\*D” (Authors: Campos, I., Divitiis, G.M., Fritsch, P., Hansen, M., Krstić Marinković, M., Patella, A., Ramos, A. and Tantalò, N.) used in Lattice QCD calculations. <http://dx.doi.org/10.20350/digitalCSIC/8591>

**Meteorology and Data Mining:** The group has a total of 14 publications. 80% are in the first quartile (4 publications are in a special issue of the Climate Services journal, and are not considered since its impact factor is not available).

This research line has also contributed to the development of open software. Half of the papers published in 2018 are reproducible using the data and software provided (including R packages published in the R journal and in Environmental Modeling and Software). This software is available at: <https://github.com/SantanderMetGroup>

**JINST**

**SPIE.**

**JHEP**  
Journal of  
High Energy  
Physics

Astronomy  
&  
Astrophysics

climate  
SERVICES

PHYSICAL  
REVIEW  
LETTERS

nature  
physics

nature  
astronomy

## 5. SCIENTIFIC AND ACADEMIC MANAGEMENT

Several IFCA members have served during 2018 in committees and steering groups of different organizations and initiatives, among others:

- Xavier Barcons. Director General of the European Southern Observatory (ESO, <http://www.eso.org>).
- José Manuel Gutiérrez. Coordinating Lead Author (CLA) of the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (<http://www.ipcc.ch>).
- José Manuel Gutiérrez. Member of the Science Advisory Team (SAT) of the CORDEX initiative of the World Climate Research Program (<http://www.cordex.org>).
- Isabel Campos has been a member of the European Open Science Cloud (EOSC, <https://www.eosc-portal.eu>) High Level Expert Group ([HLEG](#)).
- Francisco Carrera has been president of the Time Assignment Board of the XMM-Newton Announcement of Opportunity AO-18
- Maite Ceballos has been member of the Direction board of the Sociedad Española de Astronomía ([SEA](#)) in 2018.
- Silvia Mateos has been chair of the GTC Users Committee during 2018.

Moreover, some IFCA members serve in administrative, scientific or academic relevant positions:

- Jesús Marco de Lucas. Vice-president of Scientific and Technical Research of CSIC.
- Alberto Ruiz. Vice-rector of Doctoral studies and institutional relations of the University of Cantabria.
- Francisco Matorras. Dean of Faculty of Science of the University of Cantabria.
- Teresa Rodrigo, Member of the Advisory Board on Science, Technology, and Innovation of the Ministry of Science, Innovation and Universities.



## **4. KNOWLEDGE TRANSFER AND SERVICES**

- 1. Services**
- 2. Contracts**



## **KNOWLEDGE TRANSFER AND SERVICES**

The varied range of collaborations on research and innovation with Administration and industry is based on IFCA groups' expertise in instrumentation and computing techniques, but extends to the development of models and exploitation of data as in the case of the climate services. Know-how gained in the development of transducers, optical communications, image analysis, mechanical systems, sensors, etc. is the main ingredient of knowledge transfer to industry. Several projects and service agreements have been successfully developed with local companies like TTI-Norte (electronics), CIC-SL (software), Erzia (satellite communications), ASG Metrología (metrology), Draka (wire manufacturer), B3K (optical fiber manufacturer), LADICIM (test laboratory), CTC (automotive research), Ecohydros (water related sensing projects and modelling), Bosch Siemens Home (flame simulation), IBM (HPC computing), NEIKER (climate services), TRAGSA (climate services), FAO-ONU (climate services), etc.

An outstanding example is the collaboration between IFCA and ENSA (Nuclear Equipments Inc.). A project to monitor nuclear fuel using novel technologies developed at IFCA has been running for the last five years, funded by a national grant (INNFACTO). The joint research with the ENSA Advanced Technology Center (ATC), an accredited laboratory that usually participates in large international projects, is the seed for future collaborations planned within the nuclear sector. As a consequence of this collaboration, IFCA started to participate in the regional Nuclear Cluster created to coordinate the efforts of research centres and industries in this field. The collaboration with ENSA is not restricted to instrumentation: a specific framework has been setup to enable the remote use of IFCA HPC resources in ENSA innovation design projects.

An outstanding example of international transfer activities is the contract maintained by IFCA with the Food and Agriculture Organization of the United Nations (FAO) since 2012 in order to provide regional climate information and to develop data management and analysis tools, including the MOSAICC tool for agricultural impacts of climate change.

From the activities developed by the groups, two spin-off companies devoted to intelligent data analysis (Predictia S.L.) and brain analysis techniques and products (IATEC S.L.), were created in 2008 and 2009, respectively.



**predictia**

**IATEC**

## 1. SERVICES

Building on IFCA know-how and the labs and facilities described in Sec. 2.4, the Institute offers two generic services with different prestations (prizes are public and updated every year):

### SERVICE OF MECHANIZATION AND METROLOGY [\[link\]](#)

This service includes several scientific and technical prestations building on the infrastructure and equipments of the Institute (see Sec. 2.4):

#### 1. Dimensional verification

Dimensional verification of dimensional and geometric tolerances. Verification can be done by contact using the Coordinate Measuring Machine, or non-contact by means of a vision machine. This feature is integrated into the ISO 9001 quality system currently implemented at IFCA.

#### 2. Calibration magnitude length

The calibration in length magnitude corresponds to the calibration of calipers and micrometers using metallic reference blocks. This benefit is integrated into the ISO 9001 quality system.

#### 3. Use of climatic chamber for tests and thermal characterization

Use of climatic chamber with temperature control to carry out tests and thermal characterizations of instrumentation and electronics in the temperature range between -70°C and 100°C. The temperature and humidity inside the chamber can be monitored by an independent system.

#### 4. High-speed infrared image, resolution and sensitivity

Use of a high-speed resolution and sensitivity infrared camera, Xenics Cheetah-640-CL that covers the spectral band of 0.9 to 1.7  $\mu$ m and has a reading speed of 800 Hz at maximum resolution, resolution of 640 x 512 pixels, noise of reading less than 100 rms electrons and dark current less than 200000 electrons / s / pixel.

#### 5. Access to clean room

Use of the IFCA clean room to perform tasks that require a clean particle environment, such as assembling and packaging of semiconductor modules. The clean room was designed as ISO 7 or class 10,000 with a set temperature of 21°C with a range of 3°C and a relative humidity of 55%.

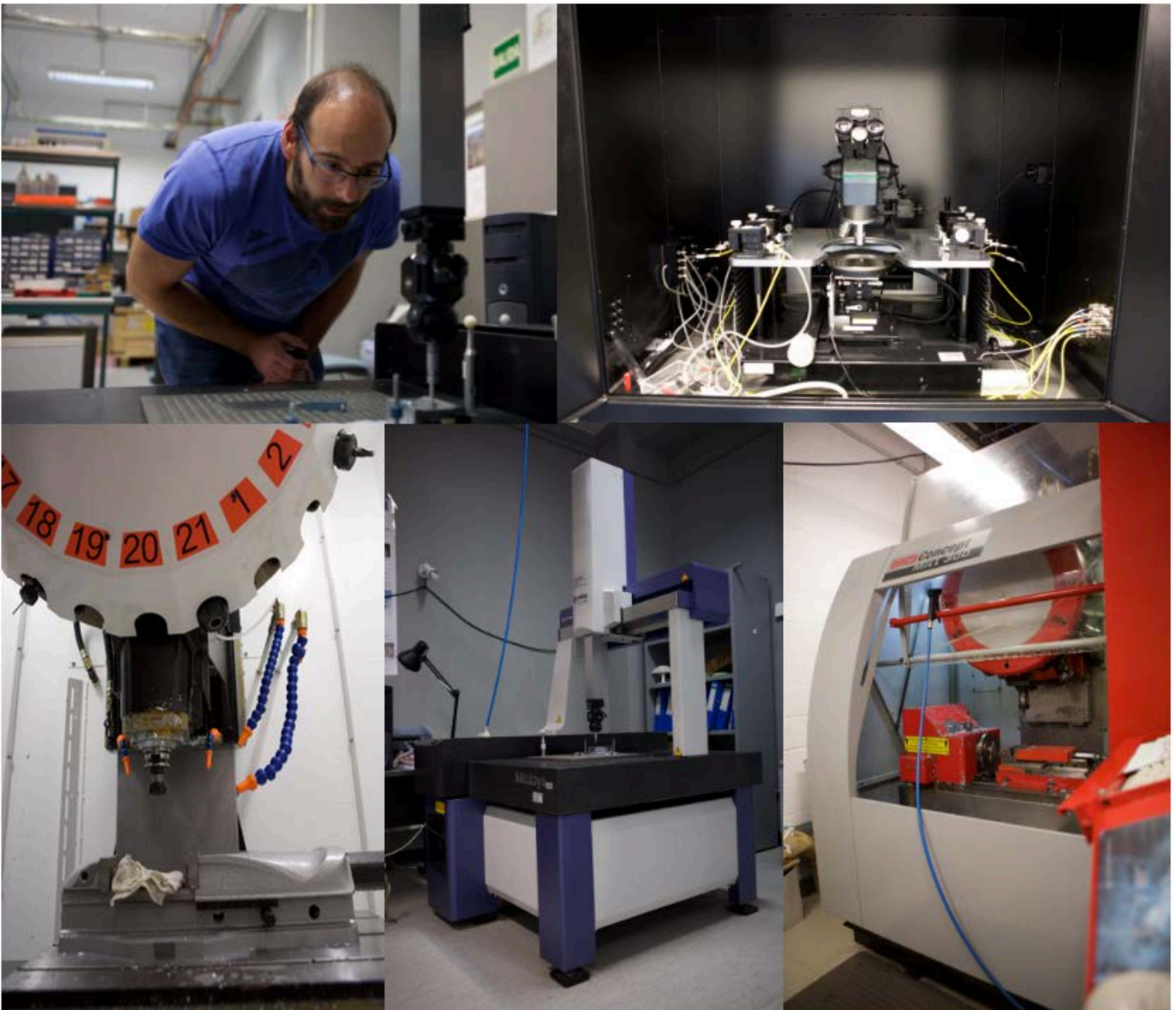


## 6. Semiconductor laboratory

The purpose of this service is the electrical and optical characterization of semiconductor components (diodes, sensors, transistors, etc.). The electrical characterization is carried out by means of a probe station, while lasers of different configurations are used for optical characterizations.

## 7. Fabrication of parts by means of a chip removal process

The performance corresponds to the precision machining by chip removal, which is within the scope of the ISO 9001 standard implemented at IFCA. We have in the workshop a numerical control milling machine and a numerical control lathe that allow us to manufacture with precision less than 25  $\mu\text{m}$  pieces with flat revolution geometry.



## ADVANCED COMPUTING (HPC, Cloud and dedicated)

[\[link\]](#)

IFCA advanced computing services builds on IFCA know-how and on the computational infrastructure of the Institute described in Section 2.4.

### 1. Cloud Services and Consulting

Develops an integral and customized strategy to perform an efficient deployment and use of cloud computing (based on the Openstack suite) adapted to the needs of the user. This service can build either on the hardware available for such effect in the IFCA (with different “flavors” defined by default) or on the client’s facilities (as a consulting service).

### 2. HPC Services and Consulting

Develops an integral and personalized strategy to carry out an efficient deployment and use of HPC computing, adapted to the needs of the user, either on the hardware available for this purpose at IFCA or on the client’s facilities (as a consulting service).

### 3. Climate Services and Consulting

Provide, facilitate and advise on the access, storage, processing and publication of climate data, as well as development and deployment of climate services. The services offered consist in the storage and consolidation of climatic data; publication of data and metadata from simulations and observations, as well as derived products; development and deployment of specialized distributed applications. [This service is performed in collaboration with the UC Meteorology and Computing Affiliated Unit]

### 3. Training

Training in technologies management and / or management of Grid, Cloud, Storage Systems, etc.

### 4. Tape Data Storage

Based on LT07 de 6/12 TB, Chasis IBM TS4500 with a maximum capacity of 10PBs. Storage, Encryption and Integrity (Checksum) of data using Bacula backup software opensource. Availability of WORM tapes.

### 5. Massive Data Transfer

Building on an internet GEANT connection of 10Gbps with protocols implemented in the IFCA are available through a redundant pool of 8 10Gbps servers: rsync, sftp, ssh, gridftp, http / https



## 2. CONTRACTS

The evolution of the knowledge transfer and service contracts of the Institute during the last five years is shown in the table below.

CONTRACTS	2014	2015	2016	2017	2018
Number	1	2	1	3	5
Amount (€)	39720 €	50394 €	30284 €	63000 €	152227 €

The following contracts with Administration and industry have started in 2018 (either transfer contracts ‘C’ or services ‘S’):

TY	TITLE	FR.	TO	IP	€	CONTRACTOR
C	NATIVE OPENID CONNECT IMPLEMENTATION FOR OPENSTACK CLOUDS	10/2018	10/2019	LOPEZ, ALVARO	39600 €	EGI.EU
C	MODELIZACIÓN HIDRODINÁMICA DEL LAGO DE SANABRIA Y DE LA APORTACIÓN DE NUTRIENTES EN SU CUENCA	06/2018	06/2019	MARCO DE LUCAS, JESÚS	15427 €	ECOHYDROS, S.L.
S	EXPANDIENDO AÚN MÁS LA CIENCIA: INVESTIGADORES EN LA ESCUELA	09/2018	12/2018	VIELVA, PATRICIO	5000 €	FUNDACION GENERAL CSIC
C	CLIMATE RISK ANALYSIS AND VISUALIZATION PLATFORM FOR ADAPTATION AND DISASTER RISK REDUCTION IN AGRICULTURE-CLIMATE COMPONENT	01/2018	12/2018	GUTIÉRREZ, JOSÉ MANUEL	53000 €	FAO: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
C	DESARROLLO DE TECNOLOGÍAS INTELIGENTES PARA LA PROMOCIÓN DE LA VIDA ACTIVA Y SEGURA	02/2018	06/2018	MARCO DE LUCAS, JESÚS	24200 €	VITALIA HEALTH
S	SERVICIO DE COMPUTACIÓN AVANZADA	01/2018	12/2018	MARCO DE LUCAS, JESÚS	15000 €	BSH
					152227 €	

It is remarkable that two out of the five contracts have been issued with international institutions: FAO and EGI (Foundation for the European Grid Infrastructure).

## **5. TRAINING**

**1. Undergraduate**

**2. Master in Data Science**

**3. Master in Physics of Particles and the Cosmos**

**4. PhD Theses**

**5. Senior Program**



## 1. UNDER-GRADUATE

IFCA has a strong participation in the whole activity of the University of Cantabria (UC). Most of the IFCA staff personnel belonging to UC come from the Modern Physics Department. Thus they participate in the undergraduate courses assigned to the department.

Moreover, IFCA has an active participation in attracting and supervising students to do research stays at IFCA during the undergraduate studies, and in offering and supervising bachelor theses as a first step of scientific careers.

Finally, members of IFCA have been and are continuously serving in academic managerial positions, and in academic advisory boards for the definition of the curricula.

### UIMP-UC Master Programs

In order to boost the multi-disciplinary activities of the Institute in two challenging cross-cutting lines of research, IFCA promoted two official (accredited by the National Education System, ANECA) inter-university Master Programs with Universidad de Cantabria (UC) and Universidad Internacional Menéndez Pelayo (UIMP), with the collaboration of the Spanish Research Council (CSIC):

- Master in Data Science
- Master in Particle Physics and Physics of the Cosmos

IFCA researchers coordinate both Masters and are actively involved in teaching and the supervision of Master Theses.



The creation of the two masters was a strategic decision of the institute to promote two themes of multidisciplinary research with great potential for collaboration across the IFCA research lines.

## 2. MASTER IN DATA SCIENCE

### Directors:

José M. Gutiérrez  
(CSIC)  
Francisco Matorras  
(UC)

### Academic coordinator:

Lara Lloret

Number of Students  
(2017/18): **15**  
(2018/19): **23**

[ [UC Web](#) ]  
[ [UIMP Web](#) ]  
[ [Flyer](#) ]

Data scientists and experts in Big Data are two of the most demanded professional profiles nowadays since they are quite new positions with still a small number of specialists in the market. It covers areas as diverse as business marketing, tourism, education, communication, research or health. There is also a new figure, the Chief Data Officer (CDO), responsible for data and strategy business information. Last but not least, there is an increasing number of opportunities for this profile in research centers all around the world.

With all this in mind, the Master in Data Science was launched in the academic year 2017/2018 as an official Master's Degree from the University of Cantabria (UC) and the Menéndez Pelayo International University (UIMP) together with the National Research Council (CSIC), being the Institute of Physics of Cantabria (IFCA) deeply involved in terms of organization and teaching.

During its first year, the degree has met a great success, corroborated by the high ratings given by the students both in terms of contents, academic structure and quality of the faculty. The number of enrolled students was doubled in the course 2018/2019 consolidating thus the degree.

**Master's Objectives:** Our era is characterized by the avalanche of data of all kinds, and in all fields. Extracting knowledge from data is the new engine of scientific, technological and economic development. In this Master, the students learn the most cutting edge techniques in Data Science with experts from the University of Cantabria, CSIC and several specialized companies. The students have access to the best resources of data and computing in Europe and are offered Internships in leading companies and research groups in areas such as Economy and Finances, Internet of Things, Biomedicine, Environment, Meteorology, Physics and Astronomy or Social Sciences. The training acquired in the Master allows the direct incorporation of the students to the professional world or to a research group allowing them to start a PhD.

The master's **faculty board** includes experts from different centres of the CSIC, including personnel of IFCA, professors from the UC (Departments of Matemática Aplicada y Ciencias de la Computación; Matemáticas, Estadística y Computación; Ingeniería de las Comunicaciones), as well as relevant experts in the field from several research centres and national and international companies.



The master's program offers three different specialization modules:

The academic organisation of the master presents thus a **great balance between theory and practice**, making this degree one of the most complete of its kind.

- **Data Science Analytics:** This module aims to provide the student with the basic knowledge on the different methodologies and techniques in Machine Learning and to apply them critically to real problems, including text and web mining. A second practical goal is to provide the standard skills and tools needed to autonomously analyse data projects.
- **Data Science Engineering:** This module aims to provide the student with direct contact with the technologies, mainly in computer engineering, which allow the deployment of the data analysis tools and the development and implementation of new solutions.
- **Open Data Management:** This module aims to provide the student with direct contact with the technologies used for the implementation of data repositories and their subsequent exploitation. The most relevant standards and the most visible initiatives are presented in different areas of knowledge within the Open Science context.

Together with the specialization modules, there is a **professional module** covering the security, privacy and legal aspects of Data Science and the newest developments on the field as dedicated seminar sessions.

One of the strongest points of this Master is the **professional orientation module**, where the students can choose between an internship in a company or research group and a set of datalabs, where they can explore real world problems guided by experts on the field.



### 3. MASTER IN PHYSICS OF PARTICLES AND THE COSMOS

**Directors:**

Patricio Vielva  
(CSIC)  
Gervasion Gómez  
(UC)

Number of Students  
(2018/19): 9

[ [UC Web](#) ]

[ [UIMP Web](#) ]

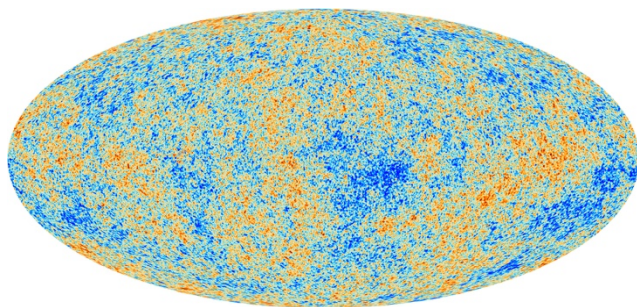
[ [Flyer](#) ]

A joint degree offered by the Universidad de Cantabria (UC) and the Universidad Internacional Menéndez Pelayo (UIMP), with the collaboration of the Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC), gathering top researches on the field from different national and international universities and research centres. It is a very young degree, established during the academic year 2018/2019, and whose organization and development strongly depends on the Instituto de Física de Cantabria (CSIC – UC).

A large fraction of the Faculty in charge of the Master conducts its research activity on different topics related to the high-energy physics, astrophysics and cosmology, being members of some of the most important experiments on the field, like those discovering the Higgs bosons, or the characterization of the most precise map of the cosmic microwave background anisotropies, among others.

The Master is addressed to graduates in Physics and related sciences, and its principal objective is to provide an advance formation on fundamental concepts and methodologies to graduate students aimed to develop a research career on particle physics, astrophysics and cosmology, paying particular attention to the clear synergies among these fields.

Attending to the selected specialization, the student will be able to deepen on the microscopic world of the high-energy physics, or in the characteristics that define the properties of the Universe as a whole by studying the astrophysical processes that take place in the structure formation and evolution. Through the Master, the student will be in direct contact with researches participating on top international collaborations.



At the end, the student will have acquired a wide and deep knowledge on two of the most thrilling and actual research fields, being ready to join a research group to carry out a PhD. It is expected that the student will have completed a formation covering both methodological and theoretical aspects.

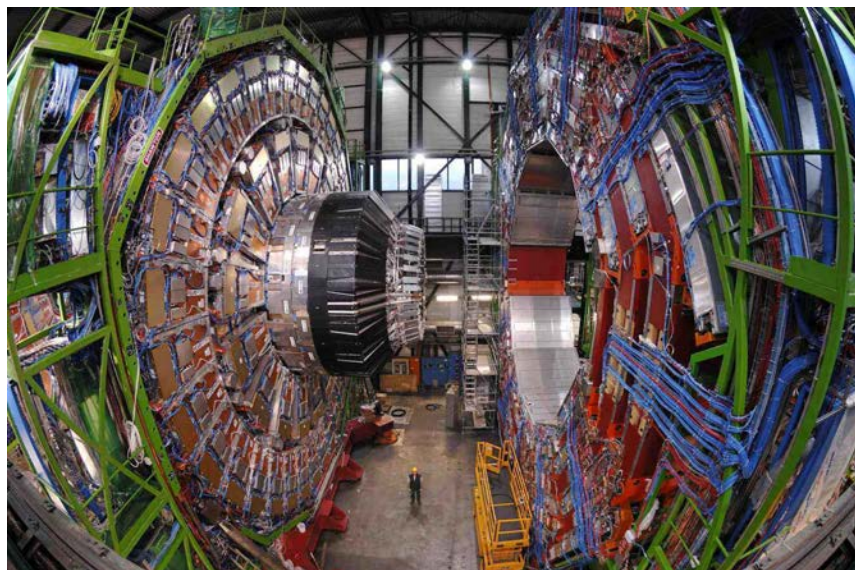
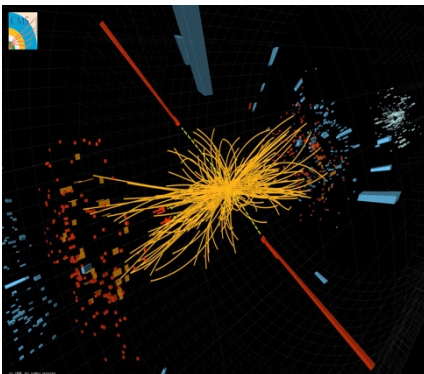
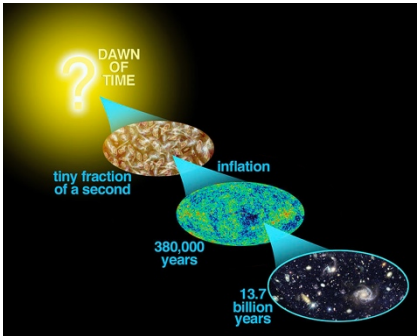
The master pays particular attention to the practical formation of the student as a researcher. In this respect, it is compulsory to carry out a long-duration Final Degree Research Project. This advanced project is carried out within a research group associated to the Faculty board of the master, and provides to the student a full experience as a researcher, not only from the point of view of facing a problem, but also by participating in the daily work of a research team with international collaborations. It is worth



mentioning that the master allows the students to apply to several Grant Programmes, in the context of the Final Degree project.

It is a one-year master (covering 60 ECTS), but with a very large offer of courses, which, in practice, allows to take up to 120 ECTS (in this case to be carried out in 2 year) to those students coming from undergraduate programmes of 180 ECTS. It is divided in four modules, as follows:

- Common module (24 ECTS, compulsory):
  - Statistics and data analysis (6 ECTS)
  - Programming in the scientific environment (3 ECTS)
  - Standard model of Particle Physics (6 ECTS)
  - Physics of the Cosmos (6 ECTS)
  - Frontier research in astrophysics and particle physics (3 ECTS)
- Final Degree Project module (18 ECTS, compulsory)
- Specialization module (12 ECTS, optative)
  - Particle Physics
    - Detection methods and techniques in Particle Physics (6 ECTS)
    - Analyses tools in Particle Physics (6 ECTS)
  - Physics of the Cosmos
    - Extragalactic astrophysics (6 ECTS)
    - Cosmology (6 ECTS)
- Advanced Research module (6 ECTS, optative)
  - Advanced astrophysics (up to 18 ECTS)
  - Advanced Cosmology and Particle Physics (up to 24 ECTS)
  - Research Project (up to 24 ECTS)
  - Advanced Computation (6 ECTS)



## 4. PhD THESIS



IFCA researches are highly involved with the Doctorate School of University of Cantabria ([EDUC](#), which was the first Doctorate School created in

Spain). For instance, Alberto Ruiz (IFCA researcher) was the first director of EDUC and he is currently Vice-chancellor on Doctorate and Institutional Relationships.

### 23 PhD Thesis in the period 2014-2018

(\*) From the UC Doctorate School (PhD Program on Science and Technology). Numbers for previous years are not available (old PhD programs).

All IFCA groups participate in the EDUC Science and Technology PhD Program and, during the 2014-2018 period, a total of 23 Theses have been defended supervised by IFCA members.

	2014	2015	2016	2017	2018
PhD Students(*)	-	-	-	19	19
PhD Thesis	7	4	3	8	1
Master Thesis	6	2	6	5	10

Many of the PhD theses have produced very important publications with a large number of citations in highly-ranked journals. One of them were awarded with the Best PhD Award (Premio Extraordinario de Doctorado) and two with the Social Council Award (Premio del Consejo Social) by University of Cantabria.

During 2018 only one PhD thesis was defended:

Juan García Ferrero: Búsqueda de materia oscura en asociación con pares de quark top en el experimento CMS. Directors: Jonatan Piedra and Pablo Martínez Ruiz. [[TESEO](#)]

During 2018, an IFCA Thesis have received the following awards:

- Rodrigo García Manzanos awarded with the “Premio Extraordinario de Doctorado 2018” to the best PhD in Sciences by Universidad de Cantabria for his Thesis: “Regionalización estadística de precipitación en la predicción estacional: ventajas y limitaciones de distintas estrategias”, directed by José Manuel Gutiérrez.
- The above Thesis has been also awarded with the “Premio del Consejo Social” 2018.

R. Manzanos

PHD THESIS: STATISTICAL DOWNSCALING OF PRECIPITATION IN SEASONAL FORECASTING

**PHD THESIS**  
**STATISTICAL DOWNSCALING OF PRECIPITATION IN SEASONAL FORECASTING: ADVANTAGES AND LIMITATIONS OF DIFFERENT APPROACHES**

**TESIS DOCTORAL**  
**REGIONALIZACIÓN ESTADÍSTICA DE PRECIPITACIÓN EN LA PREDICCIÓN ESTACIONAL: VENTAJAS Y LIMITACIONES DE DISTINTAS ESTRATEGIAS**

**AUTOR: RODRIGO GARCÍA MANZANOS**  
**DIRECTOR: José Manuel Gutiérrez Llorente**

UC  
UNIVERSIDAD DE CANTABRIA

## 5. SENIOR PROGRAM



The Senior Program of the University of Cantabria has a special activity "Approach to Science with the Institute of Physics of Cantabria" organised by IFCA. The aim of the program is bring the knowledge linked to the University to the reach of the adult population, thus allowing continuity in learning, expansion and updating of knowledge, and the strengthening of intergenerational relationships.

A visit to IFCA of a group of senior students was organized in a journey that lasted a little over two hours. The attendees became aware of the link between science and technology and the importance of scientific dissemination. Through a seminar they were able to see first-hand the different lines of research of our institute, as well as its facilities. Subsequently, we completed the workshop focusing on three specific lines: particle physics, astronomy and supercomputing.



## **6. SEMINARS AND CONFERENCES**

- 1. IFCA Seminars**
- 2. Machine Learning Journal Club**
- 3. Conferences and Workshops**
- 4. MasterClass in Particle Physics**



## 1. IFCA SEMINARS

The Cookies and Coffee (C&C) IFCA seminars are organized on a monthly basis (at least one conference per month) and offer to our researchers talks by IFCA researchers or external visitors, to publicize the work of the other IFCA research groups and try to find synergies among them.

IFCA Seminars are coordinated by Jónatan Piedra. Recorded presentations are available at the [IFCA YouTube Channel](#)



A list of organized seminars (in temporal reverse order) is provided below:

- December 2018, Santiago Velasco Forero, "Light / Dark side of deep learning"
- November 2018, Carlos Mariñas, "The Phase 2 run of the Belle II experiment"
- October 2018, Marta Seror, "When I grow up I want to be Carl Sagan"
- September 2018, Guillermo Gómez-Ceballos, "Dark Matter searches with the CMS Experiment"
- July 2018, Oleg Lebedev, "The Higgs and cosmology"
- June 2018, Lucas Lacasa, "Time series meet Network Science: visibility graphs"
- May 2018
  - Masashi Hazumi, "LiteBIRD Satellite for Tests of Cosmic Inflation and Quantum Gravity"
  - Diego Tuccillo, "Deep learning for galaxy surface brightness profiling"

- April 2018
  - Germano Bonomi, "The antimatter fall"
  - Tom Broadhurst, "New Evidence for String Theory Axions as the Universal Dark Matter"
- March 2018, Pablo Martínez Ruiz del Árbol, "Living on the Edge (of Supersymmetry)"
- February 2018, Francisco J. Carrera, "Preparing to do science with Athena: looking for the most obscured active galactic nuclei"
- January 2018, David Moya, "What does a mechanical engineer do at the Japanese High Energy Accelerator Research Organization (KEK)"
- December 2017, Mara Salvato, "AGN studies in the era of all sky surveys"
- November 2017, Amparo López, "Example of technology transfer in the IFCA: Applications of fiber optic sensors in containers of spent nuclear fuel"
- October 2017, Silvia Martínez, "The Athena Community Office"
- September 2017, Iván Vila Álvarez, "A novel non-linear optical technique for the characterization of pixel detectors for particles and imaging"

[See the list of [forthcoming seminars](#)]



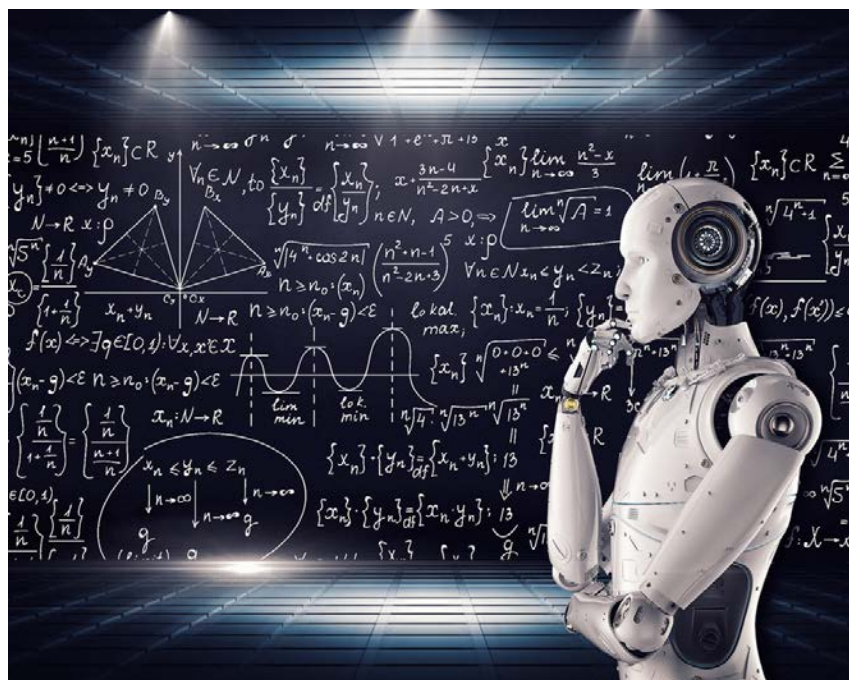
## 2. MACHINE LEARNING JOURNAL CLUB

The Machine Learning Journal Club is coordinated by Diego Tuccillo and Lara Lloret

The Machine Learning Journal Club is an open, welcoming place for researchers and PhD students to review scientific research papers on the exciting topic of Machine learning. Members will collaboratively interpret papers from a variety of fields while practicing presentation, reasoning, and critical thinking skills. The club aims to bring together academical researchers of different fields interested in staying up to date on the new frontiers of Machine learning and artificial intelligence. Members will have the opportunity to choose the club's topics and papers. We also plan to have a few seminars from invited speakers to present and discuss their research.

The Machine Learning Journal Club was organized during 2018 and started activities in February 14<sup>th</sup> 2019 with over 30 attendants from IFCA and other research groups of University of Cantabria. It will be held once a month. Next events will be announced [in this page](#).

This activity is intended to strengthen the collaboration within IFCA research lines (and with other groups of the University of Cantabria) in this cross-domain topic, which has become a new research interest of most the Groups in the Institute. The IFCA computing infrastructures and the support of the Advanced Computing Group offers an opportunity for boosting these activities in the Institute.



### 3. CONFERENCES AND WORKSHOPS

The list of conference and workshops organised by IFCA scientists, during the 2017-2018 academic year are listed below:

1. Weak and strong-lensing techniques to unveil mysteries of the Universe, EWASS 2018 - S11, April 3-6, 2018, Liverpool, UK, (<https://eas.unige.ch/EWASS2018/session.jsp?id=S11>)
2. 2nd RED LHC Workshop of Network, 9-11 May 2018, Madrid, Spain [[link](#)]
3. 2nd Workshop on correction of bias in climate studies. May 14-16 2018, Santander (<http://climate-bias-correction.org/>)
4. Treasures hidden in high-energy catalogues, Toulouse, France, 22-24 May 2018 (<https://catalogue-gems.sciencesconf.org>)
5. VI Meeting on Fundamental Cosmology, Granada, Spain, May 28-30, 2018 (<https://cafpe.ugr.es/fcosmology18/>)
6. New challenges in Data Science: Big Data and Deep Learning on Data Clouds, UIMP Santander, 18-22 June 2018 [[link](#)].
7. Dark matter 2018: From the Smallest to the Largest Scales. 25-29 June 2018, Santander (<http://indico.ifca.es/event/585>)
8. Precision Higgs Mass Calculation Workshop Series (KUTS): Paris January 2018, Wuerzburg July 2018 [[link](#)]
9. VIII GEFENOL Summer School in Statistical Physics of Complex Systems, Palma de Mallorca, Spain, 2-13 July 2018 (<https://school2018.gefenol.es>)
10. The XI edition of the 'Higgs days' in Santander. 16-20 Sep. 2018 (<http://hdays.csic.es/HDays19/index.php>)
11. DEEP All Hands Meeting. DEEP-Hybrid-DataCloud project, 18-20 September 2018, Madrid, Spain [[link](#)]
12. Santander 2018: Stellar Winds in Wind-Fed Systems. 8-11 Oct. 2018, Santander (<https://indico.ifca.es/event/516/overview>)
13. Digital Infrastructures for Research 2018, Universidad de Lisboa (ISCTE) 9-11 October 2018, Number of Participants: 480 (<https://www.digitalinfrastructures.eu>)
14. IBERGRID 2018, Universidad de Lisboa (ISCTE), 11-12 October 2018 (<https://www.ibergrid.eu>)
15. CMB foregrounds for B-mode studies, Tenerife, Spain, 15-18 October 2018 (<http://www.iac.es/congreso/cmbforegrounds18/>)
16. International Meeting of the Spanish Network for Future Accelerators. 19-20 Nov. 2018, Santander (<https://indico.cern.ch/event/763208/>)



**DIGITAL INFRASTRUCTURES**  
for **RESEARCH 2018**  
Serving the user base

9 - 11 October 2018

**LISBON**

European Week of Astronomy and Space Science  
EWASS 2018

RAS NAM 2018

LIVERPOOL 3-6 APRIL 2018

**CMB foregrounds for B-mode studies**  
*Tenerife, Spain, October 15-18, 2018*

**DARK MATTER 2018:**  
**FROM THE SMALLEST TO THE LARGEST SCALES**

JUNE 25 - 29, 2018 | SANTANDER, SPAIN

Invited Speakers:  
Joe Silk  
Ben Kilminster  
Tim Tait  
Simona Murgia  
David Cerdeño  
Alejandro Ibarra  
David Marsh  
Julian Muñoz  
Federico Lelli  
Constanze Hasterok  
Sara Alam Malik  
Tim Nelson

Scientific Organizing Committee (SOC):  
Laura Baudis  
Florencia Canelli  
Jose M. Diego  
Dan Hooper  
Sven Heinemeyer  
Alejandro Ibarra  
Igor Irastorza  
Carlos Muñoz  
Keith Olive  
Antonio Riotto  
Teresa Rodrigo  
Marisa Sarsa  
Joseph Silk  
Tim Tait  
Rocio Vilar

**DARK MATTER 2018** is a meeting devoted to discussing the latest developments in the field of dark matter. Presentations will include results from experiments in earth (colliders, direct detection, gamma rays) and space (cosmic/gamma rays, X-rays), and indirect searches for dark matter particles. The event will be held in Santander, Spain, from June 25-29, 2018. The event will take place at the Hotel Chantrel.

**SANTANDER** is a popular summer resort on the Cantabrian coast. The event will take place at the Hotel Chantrel.

LOCAL ORGANIZING COMMITTEE (LOC): Jose M. Diego, Sven Heinemeyer, Dan Hooper, Carlos Muñoz, Keith Olive, Antonio Riotto, Teresa Rodrigo, Marisa Sarsa, Joseph Silk, Tim Tait, Rocio Vilar

IFCA UC CSIC

**IBERGRID 2018**

**Meeting on Fundamental Cosmology**  
28-30 May 2018 | Granada (Spain)

*Santander 2018: Stellar Winds in Wind-Fed Systems*  
8-11 October 2018

**VIII GEFENOL**  
**Summer School on**  
**Statistical Physics**  
**of Complex**  
**Systems**

IFISC, Palma de Mallorca,  
Spain, July 2-13, 2018

Treasures Hidden in  
High Energy Catalogues

IRAP, Toulouse, France

22<sup>nd</sup>-24<sup>th</sup> May 2018

$E[\hat{\theta}] - \theta_0$  | **SANTANDER 2018**

**2nd Workshop on Bias Correction in Climate Studies**

#### **4. MASTERCLASS IN PARTICLE PHYSICS**

The 14th edition of the International MasterClasses: Hands on Particle Physics took place on Wednesday, March 7, from 9:00 a.m. to 5:00 p.m. at the Faculty of Sciences and at the Institute of Physics of Cantabria. The activity is organized by IFCA.

This activity takes place at IFCA and it is an educational journey promoted by the International Particle Physics Outreach Group.

The target audience are high school students. Students from all over the region will come to our research center, where some of our scientist will teach them about particle physics and data analysis methodology. Afterwards, students will proceed to make real measurements, using data from the Large Hadron Collider (LHC) experiments, helped by our staff.

At the end of the day, youngsters participate in a videoconference with Mostar (Bosnia-Herzegovina), Tbilisi (Georgia), Manila (Philippines) and Athens (Greece), where other groups of students are developing the same activity.

At this year edition, at the beginning of the session, at nine o'clock, dean Francisco Matorras welcomed the students and after that, the professor Alberto Ruíz made an introductory speech about the Standard Model of Particle Physics and Large Colliders. Next, the IFCA researcher Jónatan Piedra explained youngsters the CERN experimental analysis methods. Using this knowledge, the students analyse real data from LHC (CMS, ATLAS, ALICE and LHCb).



## 7. DISEMINATION AND OUTREACH

1. Expanding Science
2. Scientific Coffee
3. European Night of Researchers
4. Week of Science
5. International Day son Women and Girls in Science
6. Nighttime observations at the IFCA dome
7. Press and Media
8. Social media



## DISEMINATION AND OUTREACH ACTIVITIES

### Academic Course 2017/18



The IFCA  
**Outreach team is led by Rocío Vilar**  
and is formed by two part-time hired  
persons:  
Marta Seror and  
Pilar Monterde.

Aware of the need to create a social environment more conducive to science and innovation, IFCA organizes various dissemination and outreach activities with the aim of bringing the general public together in the daily work of a center of research.

Science is a tool that allows society to move continuously trying to improve the functioning of the world around us.

Today no one ignores the importance of the work of researchers, but science is perceived by society as a complex and distant activity, though the enormous influence that it has on our daily lives is recognised.

Boosting science and technology is essential for the advancement of modern societies. For this reason, citizens must know and understand the work we do. The outreach activities organised by IFCA aims to bring the general public to science in a fun and rigorous way at the same time, creating a channel of communication between scientists and ordinary citizens, thus making the path that separates the two shorter.

The activities that have been developed by the IFCA outreach team in the course of the 2017/18 academic year are listed below.



**1. Expanding Science:** This initiative allows the schools of Cantabria to request that an IFCA researcher to travel to their school to give seminars on various branches of Physics. This program was developed throughout the course 2017-2018 with a great success. The main recipients are students of primary, secondary and high school of all colleges and institutes Cantabria.

Teachers can choose among the various offered talks related to the different research topics of the institute. During this course we had more than 100 talks and we have reached more than 3000 students from all over the region, with the domino effect that this type of events has when reaching the teachers and families.

**Expanding Science:  
100 talks at schools  
reaching over 3000  
students.**

The themes that are offered are:

- The Big Bang, Dark Matter and Dark Energy
- Searching the unknown
- Antimatter in accelerators, hospitals and supermarkets
- How particle physics affects your life
- The Universe in scale
- Exploring the Solar System
- Stars: what are they and where do they live?
- Impressive black holes
- Exoplanets
- Life in the Universe
- The arrow of time
  - The whole is more than the sum of the parts
  - Climate change: where are we going?
  - Science in the movies



**Expanding (still more) Science:** In addition to the outreach activities Expanding Science, an initiative to bring an inflatable planetarium to schools of Cantabria was possible in 2018 thanks to the grant obtained by the program ‘Cuenta la Ciencia’ of the CSIC General Foundation. This activity has fostered scientific culture and stimulated scientific vocations in young people of a wide range of ages, as well as facilitated the

teaching and learning of science. We visited **8 centers** in our community where IFCA scientists have been responsible for presenting concepts about our present, past and astronomical future to **1500 students** of all ages (from children to high school).

Students, teachers and even the general public have enjoyed this initiative that has provided entertaining and didactic classes on planets, galaxies and constellations.

**CAFÉ**  
**CIENTÍFICO**  
INSTITUTO DE FÍSICA DE CANTABRIA



[Twitter](#)

**2. The Scientific Coffee** is an activity consisting of informal scientific dissemination talks on various areas of study carried out by renowned researchers and invites us to learn more about the world around

us: science, technology, mathematics, engineering, economics, law, humanities, etc. It takes place every last Friday of every month at the Café de las Artes (C/ de García Morato, 4, Santander), from September to June.

This activity started in 2012 and in recent years we have experienced a notable increase in public, having an average of 100 people in the sessions of this academic course.

During the 2017/2018 academic year, the following talks were given:

- Diego Herranz, Jónatan Piedra, Raquel López, “Energía oscura”, Sep. 29, 2017
- Manuel Izquierdo Fernández, "Cómo estudiar materiales en aceleradores de partículas", Oct. 27
- Federica Bertocchini, "Acumulación de plástico y gusanos de seda: ¿tenemos solución?", Nov. 24
- Carmen Sarabia Cobo, "Cerebro y materia oscura: el Universo en tu cabeza", Jan. 26, 2018
- Jesús Espinosa, "Una historia de los movimientos de hombres por la igualdad de género", Feb. 23
- Lara Lloret Iglesias, "Deep learning: revolucionando la inteligencia artificial", March 23
- Germano Bonomi, "Manual de uso para los rayos cósmicos", April 27
- Alberto Fernández Soto, "Pensamiento crítico hoy: ¿la victoria de los demonios?", May 25
- José Ramos Vivas, "Alarmismo sanitario por malas prácticas científicas", Jun. 29
- Jesús Marco de Lucas, “Ciencia hecha por máquinas”, Sep. 28
  - Roberto Ontañón Peredo, “¿Cómo surgieron los jefes?”, Oct. 26
  - Jara Martínez Sánchez, “¿Necesita mi playa una escollera?, Corrales, lindes o sirenas para otra gestión de riesgos costeros”, Nov. 25



**3. The European Night of the Researchers** is a project funded by the 7th Framework Program for Research and Development of the European Union in which researchers from more than 200 European cities dedicate a night to the dissemination of science.

This activity has as fundamental objectives:

1. Improve the visibility of researchers as part of the society by showing of their activity in public spaces.
2. Strengthen the personal links of the researchers with the rest of the personnel of each center that is involved in the activities, and with the general public, the participants.

3. To make society aware of the role that research plays in economic, social and cultural development, far from the stereotypes of an unknown activity.

IFCA developed the following activities in 2018:

➤ SCIENTIFIC GYMKHANA for children from 5 to 10 years old in the courtyard of the Cisneros, Magallanes and Antonio Mendoza schools.

➤ The IFCA's compañer@s explained what their work consists of through experiments and informative material, in the Santander Porticada square.



➤ Scientific Café with Jesús Marco: "Science made by machines", in the amphitheater of the gardens of Pereda (at the Botín Center).

**Conferences on Physics at the Ateneo Santander** organized by IFCA and covering a number of topics:

➤ Clara Grima, Alberto Coz, Diego Herranz, Jónatan Piedra, "In your Science or mine", Feb. 10, 2017

➤ Multidisciplinary discussion forum of Women Scientists of Cantabria, from different research institutions to discuss the relationship between gender and science. Besides IFCA, the participants were researchers the Institute of Biomedicine and Biotechnology of Cantabria (IBBTEC), the International Institute of Prehistoric Research of Cantabria (IIIPC), the Institute of Environmental Hydraulics of Cantabria (IHC), the Valdecilla Sanitary Research Institute (IDIVAL). Feb. 16, 2018.

➤ Francisco Javier Ayesta, "Addictive disorders: where are we losing the battle?", Mar. 2018

➤ José María Diego "X-ray the Universe through Dark Matter" (Included in the congress that is being held that week on 'Dark Matter 2018'), Jul. 2018

➤ Alberto Coz and Ramón Fernando Colmenares, "Importance of the Circular economy in our days ", Oct. 2018.

➤ José Luis Crespo, Quantum Fracture, "5 things you should know about the cosmos", for the general public, Nov. 2018

➤ M<sup>a</sup> Henar Rebollo Rodrigo. "What we should know about the vaccines", Dec. 2018



**4. The Week of Science** is a formative activity that takes place simultaneously in scientific and educational institutions such as universities, research institutes, science museums, etc., during the first two weeks of November. IFCA participates in this initiative since 2012 in collaboration with other research centers. This event consists of three main activities:

**School visits** to the Institute of Physics of Cantabria (via previous appointments with centers of the region).

**Astronomical observations.** In collaboration with the Astronomical Observatory of Cantabria. The activity is guided by IFCA experts.

**Round table** on the future of the research. With the participation of Jesús Marco de Lucas, researcher and former Director of the Institute of Physics of Cantabria.

**Talks** with José Luis Crespo, "**Quantum Fracture**": "How became YouTuber being a physicist" at the Assembly Hall of the Faculty of Sciences. Aimed at young people and / or students.



**Open-Doors Days** to bring the work of the IFCA closer to the students of primary, secondary and high school.

The main objective is to provide information on the research lines and activities developed at the Institute through a guided visit showing the facilities and laboratories where scientists develop their work. These visits are also designed to awaken the scientific vocations of young people, as it may be their first contact with the University Campus. Thus, as part of the visit some academic information is provided describing the degrees and master courses taught by the institution and their employment opportunities.

Open-door visits are organized the first Friday of each month for three groups of maximum 30 students (one hour and a half of duration each).





**5. The International Day of Women and Girls in Science** is celebrated each February 11<sup>th</sup>, in 2018 IFCA organized a program of events including different initiatives aimed at a diverse public in our region to help overcome gender discrimination and biases.

The percentage of women in certain scientific careers, such as physics, continues to be low despite the fact that the number of women in scientific positions has increased. Female professors and researchers represents a small proportion. That is why initiatives to promote scientific vocations among girls highlighting the work of women who dedicate themselves to science are important. A number of activities were organised:

➤ I Comics Contest: Women and Science



Fecha Límite: 1 Febrero  
Número máximo de viñetas: 20

Tamaño: A4

Enviar a: [difusion@ifca.unican.es](mailto:difusion@ifca.unican.es)

Incluyendo:

nombre, apellidos,  
edad, centro educativo

- Women Videos for the YouTube IFCA channel:
  - Women IFCA: the scientists tell their scientific experience
  - A video on 'What are the stars of neutrons'? executed by Javier Santa Olalla for the Women's Day in science.



Mujeres IFCA

Mujeres IFCA - CMS

Mujeres IFCA - Athena

- Our researchers collaborate with the STEM Talent Girl project, focus as well in promoting science among young women.
- Tertulia with Women Scientists at the Ateneo de Santander. The experiences of five researchers from the region were collected: Rocío Vilar, Ana Andrés, Ingrid Mateo, Diana Tordesillas and Carmen Sarabia.
- "Discover your scientists" Conference at the Faculty of Sciences, organized by the University of Cantabria. Belén Barreiro (IFCA) explained in her mini-talk how to work with the oldest light in the Universe and with the cosmic microwave background.
- 'Juego de la oca' (Game of goose) of scientific women. One of our scientists has created this fun and interesting game that explains the life of well known women scientists in history.
- Pecha Kucha vol. 5: in this occasion, the central theme was women and girls in science. In this very special format of talks composed of 20 slides in 20 seconds, many IFCA scientists participated and attended.





**6. Nighttime observations at the IFCA dome.** The observation of the night sky is one of the most enriching activities that can be experienced. Every time we look up or close our eyes to the eyepiece of a telescope we see a very special light that has crossed part of the Universe to end up in our retina.

We organize several sessions that take place at the terrace of the institute. The registration is free and more than 60 people, adults and small attended each session. Visitors were informed about the institution and the work carried out. Part of the staff of the Galaxias and AGNs and the Cosmology research groups takes care of the telescopes, helped by Physics students.

Throughout the nocturnal observations are usually seen, through the four installed telescopes, the crescent moon with its craters and seas, and the most impressive gaseous planets of the Solar System: Jupiter with its Galilean moons and Saturn with its rings. The telescopes were also pointed towards Mars, the red planet, and towards the Mizar and Alcor system, a pair of stars known to be referents in visual acuity exercises.

Schools of Cantabria visited during the activity **Expanding (still more) Science** with an inflatable planetarium.



## 7. PRESS AND MEDIA

### IFCA Press Notes

List of IFCA **press releases** during 2018:

- The IFCA receives the Accessit second in the first edition of the award on Gender Equality Distinction, organized by CSIC [[link](#)]
- Teresa Rodrigo, director of IFCA, receives the Doctorate Honoris Causa for the UIMP [[link](#)]
- The IFCA achieves the accreditation as a center of excellence María de Maeztu granted by the Ministry of Science, Innovation, and Universities [[link](#)]
- CMS celebrates 25 years [[link](#)]
- The president of the CSIC visits the IFCA [[link](#)]
- The Institute of Physics of Cantabria at the HL-LHC [[link](#)]
- QUIJOTE and Radioforegrounds meet at the IFCA [[link](#)]
- The Planck mission wins the Gruber Prize for Cosmology 2018
- 2nd Workshop on bias' correction in climate studies [[link](#)]
- Presentation of University Master's degrees at the IFCA [[link](#)]
- The Japanese particle accelerator SuperKEKB is launched [[link](#)]
- José Manuel Gutiérrez among the experts selected by the IPCC for the next report on climate change [[link](#)]
- The Hubble Space Telescope discovers the farthest star ever observed [[link](#)]
- Award for a doctoral thesis of the IFCA, Álvaro López García, who has been awarded for the best thesis presented in the area of Experimental Sciences and Mathematics with "Scientific computing in the cloud: improvements in resource planning, interoperability and federation" [[link](#)]
- Winners of the I IFCA Comics Competition [[link](#)]
- Xavier Barcons, current ESO director, visits the CERN detector CMS [[link](#)]



More information at:

<https://ifca.unican.es/en-us/news>

IFCA in the  
Regional and  
National Media

Selected references on the presence of **IFCA in the media**

May 2, 2018: Interview with IFCA researcher José María Diego "Discovering the star Icarus can help us better understand the Universe"

[[El Diario Montañés](#)] [[Antena 3](#)] [[La Vanguardia](#)] [[Cadena SER](#)]

May 14, 2018: "UIMP and UC present the Masters in Data Science and in Particle Physics and the Cosmos"

[[La Vanguardia](#)] [[Europa Press](#)]

June 1, 2018: Terasa Rodrigo, IFCA director in the jury of the Princess of Asturias Award for Scientific Research.

[[The Pricess of Asturias Foundation](#)] [[La Vanguardia](#)] [[Europa Press](#)] [[La Voz de Asturias](#)]

September 13, 2018: Teresa Rodrigo, director of the Institute of Physics of Cantabria, doctor Honoris Causa by the Menéndez Pelayo International University. [[El Faradio](#)] [[Europa Press](#)]

[[El Diario Montañés](#)] [[Website of the UIMP](#)]

September 19, 2018: Delivery of the CSIC Gender Equality Distinction

[[CSIC Protocol](#)]

September 21, 2018: Audiovisual variations for an electromechanical planetarium.

[[El Diario](#)] [[Cinentérate Cantabria](#)]

December 3, 2018: UC award with the silver medal 2018 to Teresa Rodrigo IFCA director.

[[ABC](#)] [[ifomo news](#)]

January 9, 2019: IFCA presents the Accreditation of excellence María de Maeztu

[[El Diario Montañés](#)] [[Europa Press](#)] [[El Faradio](#)]

**EL DIARIO** MONTAÑÉS

**europa press**

LA VANGUARDIA

ABC

SER

## 8. SOCIAL MEDIA



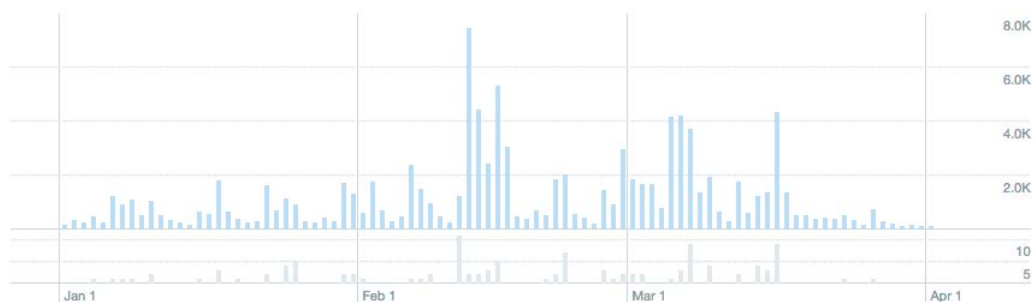
**Twitter:** We describe the visibility of our tweeters using the “impressions” metric, which is the total of all the times the Tweet has been seen (including the times it appears in a followers’ timeline and also the times it appears in search), “Likes”, for different periods of the year 2018:

From January 1 to March 31, 2018:

Number of impressions in this period: 105,000

Tweet with more impressions: 9,464

Sus Tweets consiguieron **105.0K impresiones** en este período de **91 días**



From April 1 to June 30, 2018:

Number of impressions in this period: 83,000

Tweet with more impressions: 7,896

From July 1 to September 30, 2018:

Number of impressions in this period: 110,200

Tweet with more impressions: 16,400

From October 1 to December 30, 2018:

Number of impressions in this period: 110,200

Tweet with more impressions: 30,552

During periods with peak outreach activities such as "The European Night of the Researchers" or "February 11: Day of the Woman and the Girl in Science 2018" the number of impressions increases considerably. Likewise, the month of December 2018 shows an increase due to the awards granted to the institute.

We also have a twitter for the “Café Científico” with 315 followers and an average of 20000 yearly impressions.



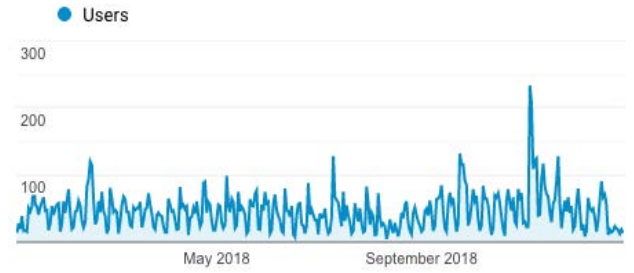
**Facebook:** IFCA Facebook has **515 followers**.

In the case of Facebook, it has not been possible to obtain the annual information since it only saves the information of the last 28 days. For the periods we have obtained information the average number of visits is about 10-20. This is substantially less followed than the news published via Twitter.



## IFCA Website

Total users: 11,899  
 Total sessions: 19140  
 Average daily visits: 100



Peaks of outstanding visits above the average of 100:

February 14th: 114 visits (probable cause: the events of Feb. 11)

July 10th: 128 visits

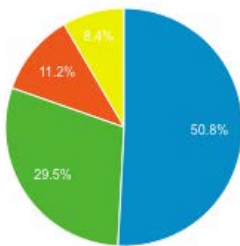
September 24th: 132 visits (probable cause: The European night of the researchers)

November 5th: 233 visits (probable cause: the Week of Science)

## Visits from different countries:

City	Users	% Users	Country	Users	% Users
1. Santander	2,826	22.48%	1. Spain	7,976	66.82%
2. Madrid	1,717	13.66%	2. United States	588	4.93%
3. (not set)	1,027	8.17%	3. Mexico	545	4.57%
4. Valencia	545	4.34%	4. France	407	3.41%
5. Barcelona	387	3.08%	5. Germany	248	2.08%
6. Paris	301	2.39%	6. United Kingdom	189	1.58%
7. Torrelavega	179	1.42%	7. Colombia	158	1.32%
8. San Luis Potosi	147	1.17%	8. Italy	129	1.08%
9. Seville	128	1.02%	9. India	127	1.06%
10. Bilbao	122	0.97%	10. South Korea	127	1.06%

## Top Channels



- Organic Search
- Direct
- Social
- Referral
- (Other)

## 9. HONORS AND AWARDS





## HONORS AND AWARDS

During 2018 several IFCA members have been awarded different prizes/nominations and have held relevant academic positions. **Teresa Rodrigo Anoro** was invested honorary doctor by the Universidad Internacional Menéndez Pelayo (Sept. 2018), in recognition of her research career.

Teresa Rodrigo and Ainoa Arteta invested honorary doctors by UIMP with the presence of local, regional and national authorities.



The president of CSIC, Rosa Menéndez, and the general secretary of Scientific Policy Coordination, Rafael Rodrigo, delivering the recognitions 'Distinctive accreditation in gender equality' to Rocío Vilar (IFCA).



IFCA was recognized with the Accésit of the Accreditation of Gender Equality of the CSIC in its call 2018. This recognition supposes an honor for the center and an incentive to deepen Equality policies.



Coordinating Lead Authors of the thirteen chapters of the IPCC AR6 WGI report during the Lead Author meeting in Vancouver, January 2018.



José M. Gutiérrez, appointed as Coordinating Lead Author of the Atlas chapter for the IPCC-AR6 report, to be delivered in 2021.

**IFCA** was awarded with the “Center of Excellence Maria de Maeztu” award which recognizes the top national organizational structures with highly competitive strategic research programmes in the frontiers of knowledge.

Public presentation of the María de Maeztu program (Santander, January 2018), including Rosa Menéndez (CSIC president), Ángel Pazos (Universidad de Cantabria Rector), Xavier Barcons (ESO director –IFCA member–), and Eva Díaz / Miguel Angel Revilla (vice-president / president of Canabria).



**Rodrigo García Manzanos** awarded with the “Premio Extraordinario de Doctorado 2018” to the best PhD in Sciences by Universidad de Cantabria for his Thesis: “Regionalización estadística de precipitación en la predicción estacional: ventajas y limitaciones de distintas estrategias”, supervised by José Manuel Gutiérrez.

This Thesis has been also awarded the “Premio del Consejo Social” 2018.



**Teresa Rodrigo Anoro** awarded with the “Medalla de Plata 2018” by Universidad de Cantabria.



Web: <http://www.ifca.es>



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YouTube [link](#)

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