


ciQUS

Centro Singular de Investigación
en **Química Biolóxica e**
Materiais Moleculares

Annual Scientific Report 2019

Cofinanciado pola Unión Europea, Programa Operativo FEDER Galicia 2014-2020
Promover o desenvolvemento tecnolóxico, a innovación e unha investigación de calidade

Unha maneira de facer Europa



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Letter from the Directors

Dear readers,

In this annual scientific report, you will find a detailed summary regarding CiQUS activity along the year 2019, a thrilling year in terms of evaluation processes, application to competitive calls, and scientific results.

Regarding both internal and external evaluation processes, 2019 was an intense and busy time for CiQUS. Early in the spring 2019, our ESAB issued the 2nd Quadrennial Assessment since our creation. The activity and research performance of the whole center and of the individual research groups was evaluated for the period 2015-2018. The overall report resulted in excellent comments and very useful advices for further improving our work and outcomes. We highly appreciate the commitment and support of all the members of our ESAB committee throughout the years. Furthermore, we must worth mentioning the appointment of Prof. Jean-Pierre Sauvage and Prof. Janine Cossy as new members of CiQUS ESAB. It is a great pleasure and honour for us to count on their advice and we are looking forward to meeting all of them in Santiago de Compostela in 2021.

The programme of the Galician Government to fund the “Galician Singular Centers” reached ended at November 2019, and therefore we needed to make extensive and detailed final report. An External Committee appointed by the Consellería de Educación, Universidade e Formación Profesional of the Xunta de Galicia evaluated the progress and scientific achievements of the 7 Research Centres holding the accreditation of “Centro Singular de Investigación do SUG” during the 2016-2019 period. We are glad that CiQUS’ evaluation was ranked as the best.

Afterwards, CiQUS applied to the competitive call for obtaining the accreditation as Centro de Investigación del Sistema Universitario de Galicia (2019-2022) during Fall 2019. As result, CiQUS’ proposal was evaluated as excellent (score A). We are really proud and thankful by the impressive effort and hard work developed by CiQUS researchers that allowed to obtain this mark. An extraordinary example of engagement, scientific rigor and ambition.

The new accreditation represents a really strong support to our research model and scientific project. We are very much looking forward to this new step. We will continue our commitment to generate high impact science at the frontier of knowledge, facing social challenges in the fields of health, environment, new materials, energy and sustainability.

In addition to this, two CiQUS applications to the Spanish State Research Agency (AEI) were submitted and granted within the call for the acquisition of scientific equipment. Finally, in 2019 we submitted a proposal to the “María de Maeztu” programme of the Spanish government, which is currently under evaluation.

Gratifyingly, our PIs got an extraordinary success in the applications to competitive international projects. An ERC Consolidator Grant was awarded to Prof. M. Fañanás (BECAME) which represents the first ERC-CoG at the University of Santiago de Compostela. Additionally, the third ERC Proof of Concept at CiQUS was awarded in January 2020 (antiCSC, PI. Prof. J.L. Mascareñas). It is also the third ERC-PoC in the Galician Region. Overall, up to 6 ERC projects have been awarded to CiQUS PIs since 2015 (8 ERC projects for a total of 5 ERC grantees). We cannot fail to mention the success in international collaborative projects such as FET-Open (SPRING, PI. Prof. D. Peña), MSCA-ITN (HeatNMof, PI. Dr. P. del Pino), POCTEC (21QBIONEURO, PI. Dr. P. del Pino) and FLAG ERA 3 (LEGOCHIP, PI. Prof. D. Peña). We have also ensured 6 projects from the AEI, a number of grants from the Regional Government, and significant contracts with private companies. We have hired one new Ramón y Cajal researcher and three Juan de la Cierva postdoctoral researchers. Up to 22 HHRR competitive contracts have been awarded to CiQUS researchers during 2019. Remarkably, over the

40% of CiQUS researchers (Postdoctoral Associates and PhD Candidates) were funded by competitive public HHRR programmes.

Importantly, under the coordination of our PI Prof. Juan R. Granja, we have launched the first academic year of the international master's degree programme associated to the center, entitled "Master in Chemistry at the Interface with Biology and Materials Science".

The impact factor of our publications in 2019 reached again an average higher than 7,5 which is quite remarkable in Chemistry and demonstrates the quality of our production. Additionally, over the 32% of our scientific papers were published in journals with IF higher than 9.

We kept our commitment to promote science among students and society by consolidating our outreach activities programme that range from hosting high school students for organized visits (including experimental activities), to the organization of open journeys for general public, scientific fairs and outreach lectures.

We are very proud of CiQUS researchers and students that are externally recognized with prestigious awards. 3 PIs have been awarded with different prizes, medals and recognitions by several scientific societies and institutions.

In summary, along the years we have improved in all significant indicators, namely, the average impact factor of our publications, our ability to raise competitive funds, the number of trainees that pursue successful careers and the impact of our technology transfer activities. We do also present better numbers in terms of gender balance, currently reaching the 40% of female staff.

Finally, we would like to note that we are issuing this 2019 CiQUS Scientific Report in the year 2020, which is being marked by the hit of the COVID-19 pandemia, an unprecedented global challenge for our society which demands the best efforts from the scientific community. We cannot end this letter without mentioning the significant contribution of the CiQUS team to this endeavour. We are proud to host two out of the twelve projects currently funded in Spain for the development of a COVID-19 vaccine, with one of them already entering preclinical trials. We firmly trust on the potential of these projects, wishing to write down their success in our 2020 Annual Scientific Report.

Enjoy reading this Annual Scientific Report!

José Luis Mascareñas
CiQUS Scientific Director

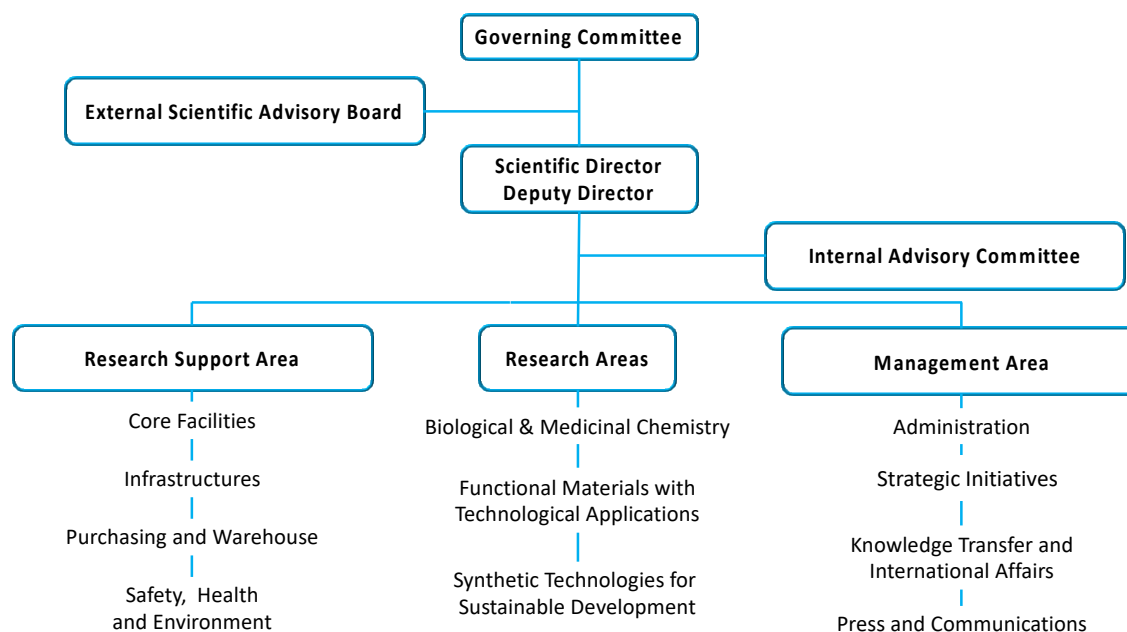
Dolores Pérez
CiQUS Deputy Director



1. ORGANIZATION

1.1. Organizational Chart & Team

The structure of CiQUS, shared by the other members of the Singular Research Centres Network (CiMUS and CITIUS), is implemented as per the organizational chart shown below.



Organizational Chart at CiQUS

GOVERNING COMMITTEE (December 31, 2019)

President: Antonio López Díaz, *Rector of the USC*

Vice-president: Vicente Pérez Muñuzuri, *USC Vice-rector of Research and Innovation*

Members: Javier Ferreira Fernández, *USC Manager*

Cecilia Sierra Rey, *USC Social Council President*

José Alberto Díez de Castro, *General Secretary for Universities – Xunta de Galicia*

Rosina López-Alonso Fandiño, *CSIC Vice-President for Institutional Affairs and Organizations*

José Luis Mascareñas Cid, *CiQUS Scientific Director*

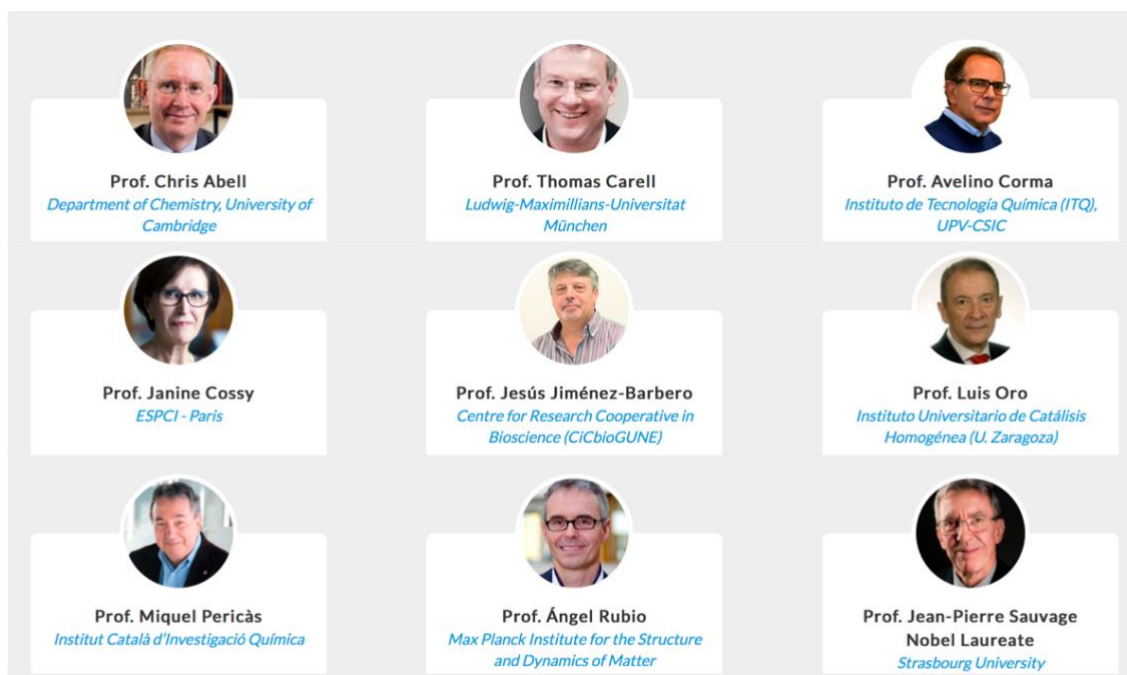
María Dolores Pérez Meirás, *CiQUS Deputy Director*

Secretary: Rogelio Conde-Pumpido Tourón. *USC R&D Management and Valorisation Director*

DIRECTORS (December 31, 2019)

Scientific Director: José Luis Mascareñas Cid

Deputy Director: María Dolores Pérez Meirás

EXTERNAL SCIENTIFIC ADVISORY BOARD (ESAB) (December 31, 2019)

Prof. Jean-Pierre Sauvage (Nobel Laureate in Chemistry 2016, University of Strasbourg) and Prof. Janine Cossy (ESPCI ParisTech) were appointed as official CiQUS ESAB members by the Governing Committee in March 2019. Furthermore, the renewal of Prof. Corma, Prof. Jiménez-Barbero, Prof. Oro and Prof. Pericàs as members of the ESAB was approved for 4 additional years during the CiQUS Governing meeting held in September 25, 2019. Additionally, Prof. Jiménez-Barbero was appointed as President of the CiQUS ESAB at the same meeting.

The CiQUS ESAB issued the Second Quadrennial Assessment of the activity and research performance of CiQUS and its research groups for the period 2015-2018 in April 2019. This evaluation included an on-site visit on April 4th by the ESAB members Prof. Jesús Jiménez-Barbero, Prof. Luis Oro, Prof. Miquel Pericàs and Prof. Ángel Rubio. They spent two days in Santiago de Compostela carefully analyzing in detail the corresponding annual scientific reports of the period as well as the specific information provided by CiQUS PIs, which had been previously requested. All CiQUS ESAB members had previously received all these reports by email.

During the stay, they held interviews with CiQUS Directors, several CiQUS PIs, CiQUS Governing Committee, as well as some other members of the *Consellería de Educación, Universidade e Formación Profesional* of the Xunta de Galicia Government. The overall evaluation report resulted, in general, in excellent comments and very useful advices for CiQUS improvement.

1.1.1 Directors

- **Scientific Director:** *Prof. Dr. José Luis Mascareñas Cid*, Full Professor of Organic Chemistry (full-time).

Professional profile: José Luis Mascareñas (Allariz, 1961) completed his PhD at the USC in 1988. He was a postdoctoral fellow at Stanford University (USA) under the supervision of Prof. Paul Wender (1989-1990). He became permanent professor in 1993 and full professor in 2005, at the USC.

He has been a visiting scholar at Harvard University (USA) and a visiting scientist at the University of Cambridge and the MIT. As independent researcher, he has published over 185 articles, the majority of them

in the most relevant chemistry journals, 8 book chapters, and 21 patent applications. He has supervised 35 PhD theses, delivered more than 130 invited lectures, most of them in international forums, and raised over 5 million Euros in competitive grant calls in the last 5 years. Many students from the group have received relevant awards and many of them have started relevant academic careers. One of them, Dr. Elena Pazos, now professor in the University of Coruña, has even gained a prestigious ERC starting grant in 2019. In 2014, Prof. Mascareñas received an **ERC Advanced Grant** for his project METBIOCAT (<http://metbiocat.eu/>) and, more recently, an **ERC Proof of Concept** (antiCSC, 2020).

His current research splits between a synthetic program aimed at discovering novel methods based on metal catalysis, and a chemical biology program focused on the development of synthetic tools for biological intervention. The Spanish Royal Society of Chemistry awarded him the Organic Chemistry Award (2009) and **Gold Medal** (2015). In 2016, he was appointed as member of the European Academy of Sciences. He was appointed Scientific Director of CiQUS in February 2014. In the CiQUS Governing meeting held in September 25, 2019, the renewal of Prof. Mascareñas as CiQUS Scientific Director for a new 4 years period was approved.

- **Deputy Director:** *Prof. Dr. María Dolores Pérez Meirás*, Full Professor of Organic Chemistry (full-time).

Professional profile: Dolores Pérez (Ferrol, 1964) completed her graduate studies at the USC with Honours and obtained her PhD in 1991, under the supervision of Prof. E. Guitián and L. Castedo. She was awarded a MEC-Fullbright fellowship to conduct postdoctoral training at the University of California at Berkeley (1992-1993) in the group of Prof. K. Peter C. Vollhardt, and later she was a visiting scientist in the group of Prof. S. L. Buchwald at MIT (1996). She joined the faculty of the USC as Assistant Professor in 1995, became an Associate Professor of Organic Chemistry in 2000 and Full Professor in January 2019.

She has published over 60 articles in high impact journals, 3 book chapters and supervised 10 PhD theses. Her current research interests are focused on the discovery of new metal-catalyzed reactions of synthetic interest, the further development of aryne chemistry and its application in the synthesis of complex polycyclic aromatic systems and nanographenes. She has been Director of the Organic Chemistry Department (2004-2006), and associate to the Vice-rector of Research and Innovation at the USC (2006-2010). In 2010, she was appointed as Commissioner Director of CiQUS, where she has worked as Deputy Director since 2014. From September 2017 to June 2018, she was also Commissioner of the USC Rector for Campus Vida and for the Coordination of the Singular Research Centres Network.

1.1.2 Management Structure

CiQUS Management body is organized in several different units which give support to the scientific and non-scientific activity of the centre:

- **Internal Advisory Committee**, which is representative of the main research areas at the CiQUS. It is responsible for the elaboration and monitoring of the CiQUS Strategic Plan. It is made up of CiQUS PIs: *Ricardo Riguera, Juan R. Granja, Antonio Fernández, Pablo del Pino, Dolores Pérez and José Luis Mascareñas*. María Gimenez is also part of the internal advisory committee since fall 2019.
- **Management Area:** This area integrates 4 different units:
 - ✓ Administration Unit: responsible for the financial management of R&D activities, secretarial issues and administrative support (*Elena Veiga and Lucía Rodríguez*).
 - ✓ Strategic Initiatives: coordination of CiQUS scientific strategic project, writing of scientific and activity reports and talent attraction programmes (*Dr. Almudena García*). A new support technician was hired for this unit in August 2019 (*María Regueira*).

✓ Knowledge Transfer & International Affairs: promotion of international R&D initiatives and identification of technology transfer opportunities (*Fernando Casal*).

✓ Press and Communications Unit: created to develop a joint communication strategy with the CiMUS and the CiTIUS. This unit is responsible for CiQUS' press releases and social media networks (*Andrés Ruiz and Elena Mora (for personal reasons, she resigned in May 2019)*).

• **Research Support Area**: responsible for the implementation of the centralized operational model which gives technical support to CiQUS' research activity, aiming at the optimization of the available resources and the improvement of the working conditions at the centre. This area integrates 4 different units:

✓ Core facilities: provides the scientific instrumentation support needed to carry out research at CiQUS, ensures the maintenance and best use of the equipment, and offers training in the use of the equipment, samples preparation and processing data (*Dr. Arcadio Guerra, Laura Acevedo*).

✓ Infrastructures: responsible for the management and maintenance of labs, equipment, furniture and general spaces at CiQUS (*Laura Acevedo*).

✓ Purchasing and Warehouse: responsible for the negotiation and purchasing of reagents, solvents, disposable laboratory products and management of the CiQUS' warehouse (*Noela Torrente, Pablo Cajaraville*).

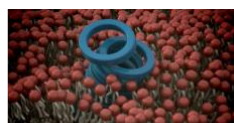
✓ Safety, Health and Environment: responsible for the initial training course on safety and risk prevention for all new CiQUS members. Elaboration and maintenance of CiQUS' Self-protection plan, coordination and training of the emergency teams and management of the laboratories' safety (*Noela Torrente, Pablo Cajaraville*).

1.2 Scientific Structure

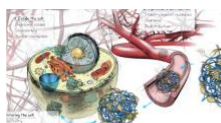
CiQUS research activity is organized so as to optimize efforts and promote collaborations and synergies between the different research groups and disciplines within the centre. In 2019, CiQUS scientific activity was still aligned with the Scientific Strategic Project (SSP) designed within the "*Centros Singulares de Investigación of Galicia (2016-2019)*" framework program. In this context, the research activity of CiQUS research groups was mainly focused on three major areas:

- BIOLOGICAL AND MEDICINAL CHEMISTRY
- FUNCTIONAL MATERIALS WITH TECHNOLOGICAL APPLICATIONS
- SYNTHETIC TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

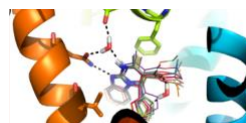
A Biological & Medicinal Chemistry



**A1. BIO-SUPRAMOLECULAR
CHEMISTRY**



**A2. NANO CHEMISTRY AT THE
FRONTIER WITH CELL
BIOLOGY**

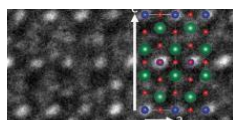


**A3. NEW PHARMACOLOGICAL
AGENTS AND STRATEGIES FOR
DRUG DELIVERY**

B Functional Materials with Technological Application



**B1. INNOVATIVE FUNCTIONAL
MATERIALS AND TECHNOLOGIES**



**B2. SENSORS; THERMAL AND
ELECTRONIC DEVICES**



**C1. CATALYSIS AND SYNTHESIS
FOR SUSTAINABLE
DEVELOPMENT**



**C2. DESIGN AND DEVELOPMENT
OF CHEMICAL TECHNOLOGIES
FOR PRODUCT HEALTH**

CiQUS Scientific Organization

According to this organization, the main research activities in each of the topics, were:

I. BIOLOGICAL AND MEDICINAL CHEMISTRY

Research in this area focuses on the fields of supramolecular, biomolecular and cellular chemistry as well as biomedicine, and addresses pressing medical problems and challenges in cancer, neurodegenerative diseases and bacterial resistance. Our current organization includes subtopics associated to different PIs:

- **BIO-SUPRAMOLECULAR CHEMISTRY:** a) Novel supramolecular devices based on peptides and biological applications (PI: J. Granja); b) Metallopeptides for nucleic acid interactions (PI: E. Vázquez). c) Protein, polymer and peptidoglycane folding (PIs: F. Freire, E. Quiñoá; PIs: R.J. Estévez, J.C. Estévez); c) Peptide helicates and oligomeric auto-assembled receptors (PIs: E. Vázquez, M. Vázquez); d) Assembly of supramolecular systems and its influence in chemical reactivity (PI: L. García Río).
- **CHEMISTRY AND NANOTECHNOLOGY AT THE INTERFACE WITH CELL BIOLOGY:** a) Metal catalysis in biological habitats: New strategies for optical bio-sensing and targeted therapy (PI: J.L. Mascareñas, ERC-AdG-MetBioCat); c) Molecular fluorescent probes to be used in cell biology (PIs: E. Vázquez, M. Vázquez, M. Mosquera); d) Artificial cells: design and synthesis of a fully synthetic self-regulated cytoskeleton (PI: J. Montenegro, HFSP-RGY0066/2017).
- **PHARMACOLOGICAL AGENTS AND NEW STRATEGIES FOR DRUG TRANSPORT AND DELIVERY: APPLICATION FOR DIAGNOSIS AND TREATMENTS:** a) Smart materials for cellular transport of proteins, nucleic acids and cytotoxic molecules and controlled drug delivery (PI: J. Montenegro, ERC-StG-DYNAP); b) Novel antibiotics for resistant bacteria (PI: C. González-Bello). c) Combinatorial technologies for drug discovery (PI: E. Sotelo); d) Antibiotics as mitochondria-targeted antitumoral agents (PI: E. Vázquez, Spanish Association Against Cancer-AECC); e) Activation strategies of antitumoral prodrugs based on nanoparticles (PI: P. del Pino); f) Biotechnological tools and novel strategies for vaccine design (PI: José Martínez-Costas); d) Nanostructures and dendrimers for conjugation with ligands of biomedical interest with applications in drug delivery or diagnosis (PI: E. Fernández-Megía).

II. FUNCTIONAL MATERIALS WITH TECHNOLOGICAL APPLICATIONS

This area is aimed at the discovery of new organic, inorganic and metallo-organic materials with unique properties, as well as their implementation in the development of technological devices for biomedical applications and the design of new molecular electronic and energetic technologies.

- **INNOVATIVE MATERIALS AND TECHNOLOGIES:** a) Inorganic and metal organic materials with novel thermal, magnetic or reactivity properties (PI. M. Lazzari); b) Nanomaterials with applications in the restoration of works of art. (PI. M. Lazzari); c) Organic semiconductors: synthesis in solution and on surface, and biomedical applications (PIs. D. Pérez, D. Peña and E. Guitián); d) Nanostructures for the control of thermal conductivity based on optical methods (frequency domain thermorefectance, FDTR) (PI. F. Rivadulla); f) Nanoparticles, MOFs and hybrid nanostructured materials with applications in drug delivery, theranostics or as cell reprogramming agents (PI. P. del Pino); g) Multifunctional metal-carbon hybrid nanostructures for spintronics and energy-related applications (PI: M. Giménez).
- **SENSORS: THERMAL AND ELECTRONIC DEVICES:** a) Devices for ultraprecise thermal measurements (PI. F. Rivadulla); b) Functional polycyclic aromatic hydrocarbons (PAHs) and nanographenes: synthesis and applications (PIs. D. Peña, D. Pérez, E. Guitián); c) Stimuli-responsive dynamic polymers (PIs. R. Riguera, E. Quiñoá and F. Freire).

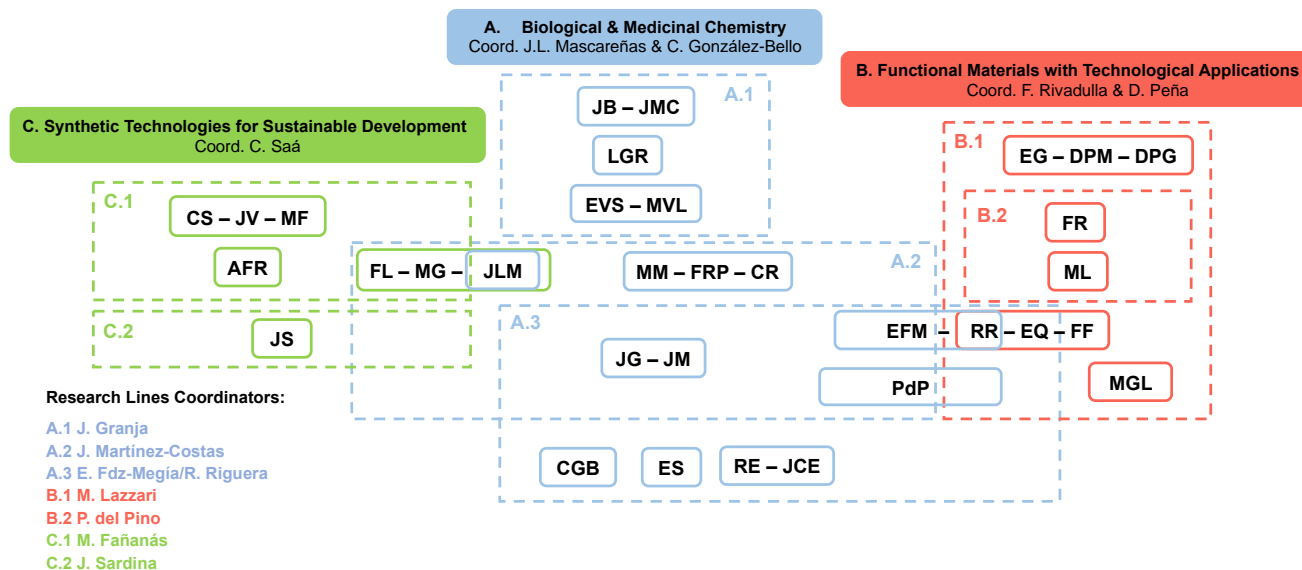
III. SYNTHETIC TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

Discovery of effective catalytic processes and sustainable synthetic methods.

- **CATALYSIS AND SYNTHESIS FOR A SUSTAINABLE WORLD:** a) Metal-based technologies for C-H activation/C-C bond formation (PI. M. Fañanás); b) Catalytic functionalisation of “inert” C-H bonds: new tools for synthetic chemistry (PIs. M. Gulías, J.L. Mascareñas); c) Efficient synthetic methods based on metal catalysis for the preparation of enantiopure anticancer agents (PIs. F. López, J.L. Mascareñas); d) New catalytic routes for the preparation of doped PAHs and bioactive heterocycles (PI. C. Saá); e) Theoretical methods and mechanistic studies (PIs. A. Fernández-Ramos and J. Varela).
- **CHEMICAL TECHNOLOGIES FOR PRODUCT HEALTH:** This line was developed in collaboration with the company INDITEX, S. A. This collaboration is aimed at the application of chemistry technology for the development of sustainable processes for the textile industry (PI. J. Sardina): a) Minimize the use of toxic substances; b) Development of novel technologies for textile recycling. Despite this type of research is somewhat lateral to the main scientific stream of the centre, it is very useful from a socioeconomical perspective because it allows an immediate recognition by social actors of the value of chemical research.

Despite each group focuses on specific thematic and research lines, the scientific organization has been designed to facilitate interactions and synergies between groups of experts on different subjects and thus allow to pursue interdisciplinary projects and relevant scientific challenges from an interdisciplinary perspective.

CiQUS Strategic Scientific Project 2016-2019



CiQUS Organizational Chart for Scientific Activity (2016-2019)

For a more detailed description of the different research lines of the Strategic Scientific Project, see <https://www.usc.es/ciqus/en/research/research-groups>.

In May 2019, CiQUS presented the final evaluation report within the “Centros Singulares de Investigación” (2016-2019) Programme of the Galician Government. This competitive programme represents the main funding source for CiQUS. The progress and scientific achievements of CiQUS during that period were evaluated by an External Committee appointed by the Consellería de Educación, Universidade e Formación Profesional of the Xunta de Galicia Government. The result of that evaluation was published at the official website of the programme (only available in Galician):

<http://www.edu.xunta.gal/portal/sites/web/files/resultadoavaliacionfinal.pdf>

Afterwards, CiQUS applied to the new competitive call for obtaining the accreditation as **Centro de Investigación del Sistema Universitario de Galicia (2019-2022)** [Research Centre of the Galician University System (2019-2022)]. **CiQUS’ proposal was evaluated as excellent (score A)** in December 13, 2019. Thus, CiQUS will receive a grant of 2.89 M € for the period 2019-2022. The results of this call are available (only Galician version) at the official website of the programme and also at the “transparency” section of CiQUS website:

http://www.edu.xunta.gal/portal/sites/web/files/20200113_acreditacion.pdf

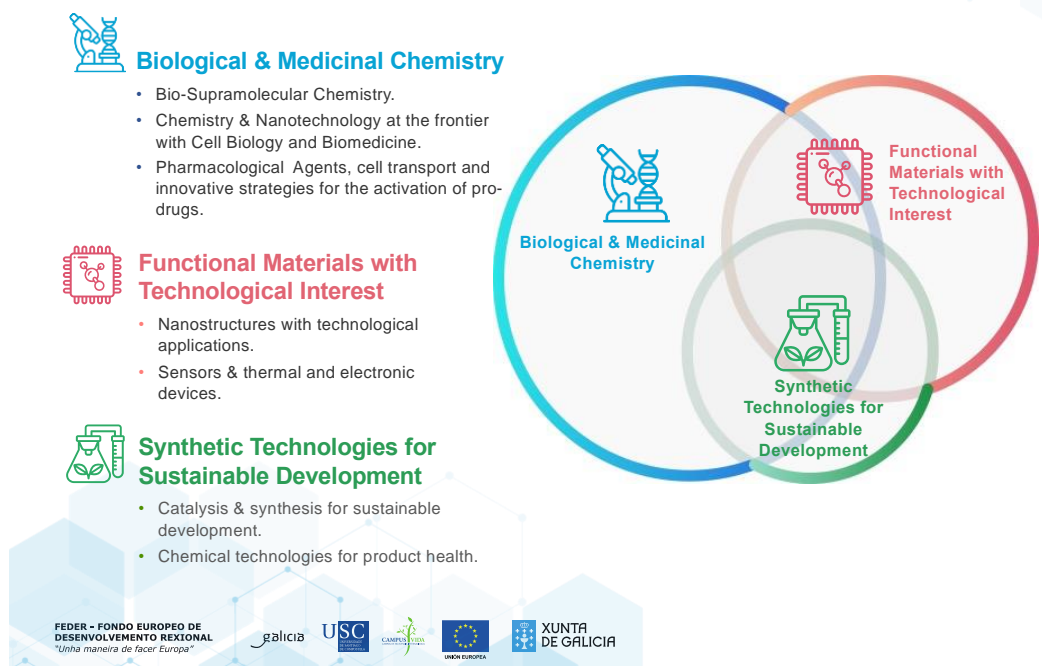
<https://www.usc.es/ciqus/en/about-ciqus/transparency>

In line with this new accreditation, CiQUS is currently involved in the implementation of the new Strategic Scientific Programme for the period 2019-2022 and a Strategic Plan (2020-2023), which require a re-organization of CiQUS scientific capacities and structures. Although the details of the SSP (2020-2023) will be presented and discussed in the Annual Scientific Report 2020, some developments are detailed below:

For the 2019-2022 project, CiQUS will exploit the full potential and quality of its research groups in the most effective way to generate science of high impact on the frontier of knowledge, researching on solutions to face social challenges in the field of health, environment, and new materials and energies, in line with those indicated in the H2020 program or in RIS3 Galicia.

In this context, several new different research lines will be initiated at the centre. For example: **1) “SPRING” (FET-OPEN)**: A team led by PI. Diego Peña will explore the use of custom-crafted graphene nanostructures as elementary active components of a new generation of nanoscale quantum spintronic devices, which can be potentially used for transporting, storing and processing information; **2)** Dr. Martín Fañanás will start the **BECAME** project (ERC-CoG) for the development of a catalytic methodology based on synergistic processes to transform methane and other abundant feedstocks into high value-added products; **3)** A new research line will study **Photocatalytic Processes inside cells** (Dr. María Tomás); **4)** Dr. María Giménez will evaluate the potential use of hollow carbon structures with confined metal nanoparticles as **technological platforms for energy storage and conversion**; **5)** A new research line for developing of **new materials for nanomedicine** application will be led by Dr. Beatriz Pelaz; among others. Remarkably, a project led by Prof. José Martínez-Costas will be funded by the Institute of Health Carlos III (ISCIII) within the framework program “Extraordinary Funding for Research Projects on Sars-Voc-2 and Covid-19 Disease. This project *“Development of a vaccine against SARS-VOC-2 by means of muNS-Mi micro / nanospheres”* will study the production of vaccines using the IC tagging system, one of the new CiQUS strategic research lines for the period 2019-2022.

CiQUS STRATEGIC SCIENTIFIC PROJECT (SSP) 2019-2022



Furthermore, **actions will be intensified to promote interaction between the different areas of knowledge and the intramural collaborations**, ensuring that all the PIs and groups can participate in each research line within the new Scientific Strategic Project.

2. RESOURCES

2.1 Facilities

The CiQUS building covers a built-up area of 5,900 m² and has 22 research labs, which have been designed under the criteria of flexibility, safety and sustainability, and are provided with first class laboratory furniture that meets the needs of the different research areas. There are also 1,000 m² of research support facilities, including a Nuclear Magnetic Resonance (NMR) facility, a radioactive facility, a high-pressure laboratory (placed on the roof), cell culture laboratories, a dark room, cold rooms, four rooms for chemical storage, a central purchasing centre and a computer cluster. CiQUS researchers also have access to the nearby general research support services of the USC (www.usc.es/gl/investigacion/riaidt/) at the CACTUS building.

Most notably are the **four research support laboratories** which host most of the scientific equipment provided by the research groups or acquired by the centre: chromatography SFC, GC, HPLC, MS-GC, MS-HPLC, circular dichroism, lyophilizers, glove box, Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Dynamic Light Scattering (DLS), fluorescence microscopy for live-cell imaging, etc. All these laboratories operate on a shared use basis, under the supervision of the technical staff, thus optimizing the resource availability. In addition, there are some highly specialized labs: Live-cell imaging Lab, AFM microscopy, lithography, electrophysiology, PLD, etc.



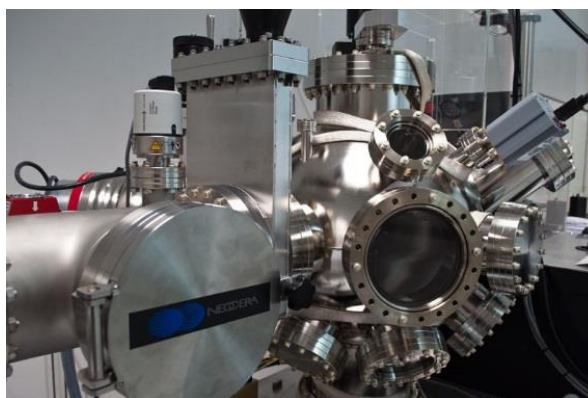
Representative research support laboratories

Yet again, it is very important to emphasize that the management structure of the centre contributes to the optimization of available resources by promoting the shared use of equipment, both the instruments provided by the different groups and those specifically purchased for general use. Sharing equipment also allows for expert exchange of different instrumental techniques and for the development of scientific collaborations and interdisciplinary projects. The central purchasing of solvents and other consumables is also very relevant from an economical and safety (reduction of stocks of hazardous and flammable materials) perspective.

2.2 Singular Laboratories

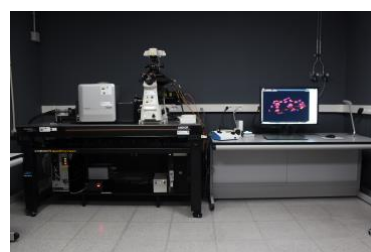
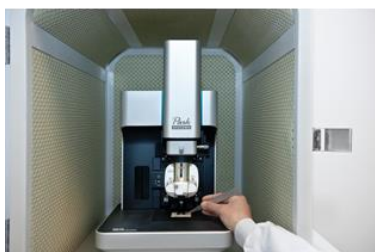
• **Thin Films Laboratory:** This Lab specializes in the fabrication of thin films and multilayers for different uses, mainly oxide thermoelectrics and ferroic materials. The lab is open to collaborations, includes state-of-the-art nanofabrication tools and techniques for a wide range of applications.

It is equipped with a **PLD** (Pulsed Laser Deposition) for the generation of thin films, acquired by F. Rivadulla (ERC-StG “2D THERMS” and ERC-PoC “ANTS”). This is an ultrahigh vacuum laser deposition system with a load lock chamber and a 200 mJoule F-Kr (248 nm) laser. It allows substrates to be heated up to 1000 °C and it is provided with a six-target carousel. It is also equipped with a **lithography facility** with an etching and coating system, including two deposition guns in the same vacuum chamber. This system is employed for film patterning using stencil masks and subsequent depositions of Au, Ag, etc. (four different targets) or transport measurements, such as Hall effect, magnetoresistance, etc. Finally, the research group of Prof. Rivadulla has also developed a **Polymer Assisted Deposition** (PAD) technique, a wet “green” chemical method for large areas, suitable for high quality ultra-thin films of different oxides and nitrides.



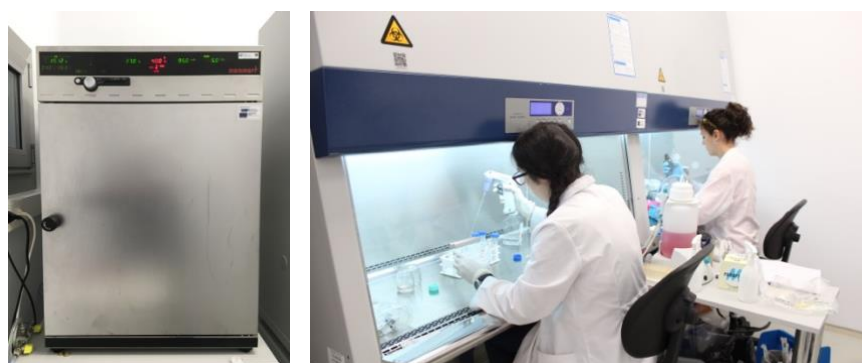
PLD equipment

• **AFM microscopy laboratory.** It has a state-of-the-art AFM microscope, NX-10 Park Systems, designed to work in multi-user mode (high degree of automation) and capable of studying surfaces with a resolution in the region of 1 nm, and high-resolution modes for the analysis of structural motifs at submolecular level, and additional modules of electrical conductivity and thermal conductivity. This equipment was purchased jointly by the CiQUS (40% of the cost) and five of its research groups (12% of the cost each), an example of the level of cooperation within the centre.



Rooms for AFM microscopy (left), lithography equipment (centre) and living cell microscopy (right)

- **Laboratory of living cell microscopy.** In September 2015, thanks to the joint efforts of several CiQUS groups and a CiMUS group (Mabel Loza), CiQUS acquired a fluorescence microscope “Nikon Eclipse Ti” for the study of living cells. In 2017, CiQUS acquired, thanks to a grant from MINECO for the acquisition of scientific infrastructures (co-funded by ERDF), a confocal microscope with spinning-disk and TIRF modules “Nikon Dragonfly”. The confocal spinning disk module allows the acquisition of images at high speed and is the technique of choice for studying living cells with confocal microscopy, which is key for many ongoing projects in the centre. The TIRF module allows the observation at specific sites in the cell. This equipment will be fundamental for the development of several research lines within the area of Biological & Medicinal Chemistry. Additionally, in order to improve the biological area, a new lab has been adapted for cell culture, with the installation of two biosafety cabinets and the acquisition of an incubator.
- **Laboratory of cell culture.** In line with the emerging research projects based on biological and medicinal chemistry, CiQUS has established a new laboratory for cell culture. This new facility is located at the CiQUS ground floor and it has been equipped with two biosafety cabinets, a centrifuge and a cell culture incubator among other cell culture common stuff. In 2019, the two biosafety cabinets received the Biosafety Level 2 (BSL-2) certification and validation.



Cell culture lab equipped with a cell culture incubator (left) and two cell culture biosafety cabinets (right)

2.3 New Equipment

In 2019, CiQUS improved the research facilities available at the centre with the acquisition of different equipment: a new GCMS (acquired thanks to the national competitive call for the acquisition of scientific-technical equipment launched in 2018 by the Agencia Estatal de Investigación (AEI) of Spain), a Recycling Preparative HPLC, a lyophilizer and 2 Microsoft Surface Hubs.

As a major infrastructural improvement for the development of some research lines at CiQUS, a new high-resolution Transmission Electron Microscopy (TEM) became operative in November 2019. Specifically, a JEOL JEM- F200CF-HR microscope, currently located at the CACTUS building, was acquired thanks to the financial support of the Consellería de Educación, Universidade e Formación Profesional (1.4 M€). The technical capacities of this instrument are fundamental for the development of research lines at CiQUS related with soft-matter and, in particular, for the area of carbon-based materials (including the ERC-Starting Grant NANOCOMP, PI Dr. María Giménez).

Additionally, CiQUS submitted 2 application proposals for the new call for the acquisition of scientific technical equipment launched by the AEI in 2019. Both proposals were positively evaluated. Thus, CiQUS will received 0.42 M € for the acquisition of a spectroscopy equipment comprising a UV-Vis-NIR spectrophotometer combined with a high sensibility and extended range spectrofluorometer; and a hyperspectral image platform (HSI) for fluorescence microscopy. This equipment will further strengthen the research capacities at the CiQUS.

Furthermore, CiQUS PIs regularly support and/or lead other proposals for the acquisition of equipment for the general R&D services of the University of Santiago (CACTUS). In this context, an application proposal led by Prof. F. Rivadulla (CiQUS PI) will be funded for the acquisition of an ionic polishing equipment for the preparation of transmission electron microscopy and scanning samples (0.20 M €) by the AEI.

3. SCIENTIFIC REPORT 2019

The following chapters describe and summarize CiQUS key research capabilities as well as its scientific activity in 2019, but more detailed information is available in the Annexes section and the CiQUS website: www.usc.es/ciqus/en.

3.1 Human Resources

32 Principal Investigators (PIs), 47 postdocs, 91 PhD candidates, 24 Master students and 19 Technical and administrative assistants (7 of them are directly hired by CiQUS research groups, under their own R&D research projects, for supporting them with administrative issues and/or technical research tasks) (Dec 31, 2019)

In December 2019, more than 200 people (41% female, 10% foreigners from up to 12 different countries) were working at CiQUS: 32 Research Staff (3 of them, *Ramón y Cajal* associates), 47 postdoctoral researchers (2 *Ramón y Cajal* associates, 7 *Juan de la Cierva* researchers, 1 MSCA-IF and up to 10 Xunta's postdoctoral researchers; 38% were female and around 15% of CiQUS postdoctoral researchers comes from abroad), 91 PhD candidates (46% female and 10% foreigners), 24 MSc students (46% female) and 6 visiting researchers, together with 10 research support technicians (4 of them are technicians hired by particular groups), 9 people in the administrative department, R&D management and service tasks (3 of them are technicians hired by particular groups for administrative support). Furthermore, around 9 USC faculty members collaborate in CiQUS scientific activity on a daily basis, though they are not officially appointed by the CiQUS. The full list of people (as for December 2019) is included in Annex I.

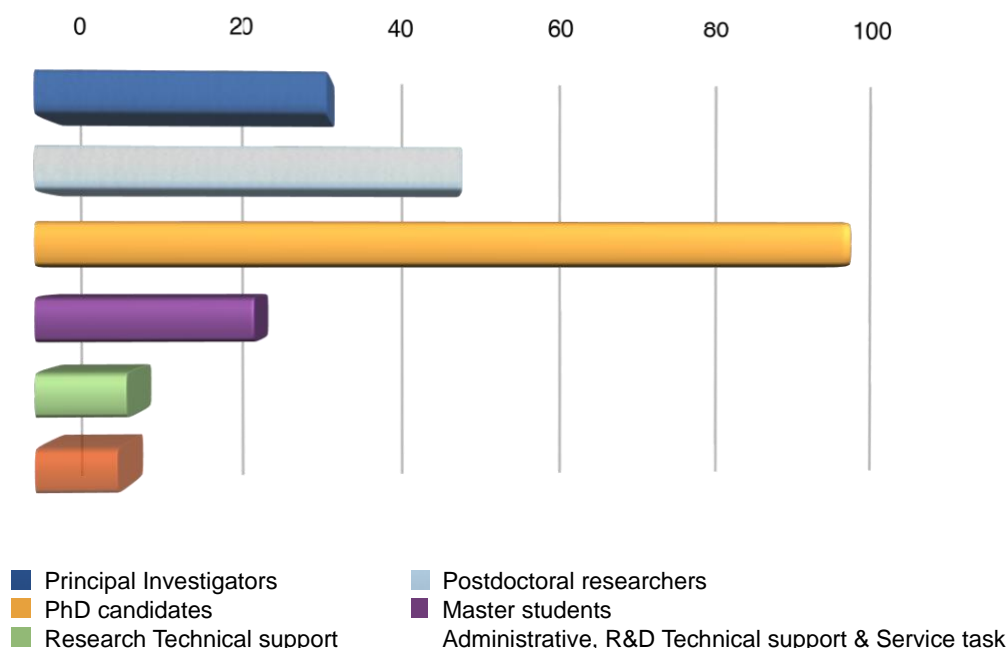


Chart 1. Distribution of human resources by category

At the beginning of 2019, Prof. V. Sánchez-Pedregal resigned from his position as Principal Investigator at CiQUS for personal reasons. This request was approved by CiQUS Governing Committee in March 2019. Prof. Sánchez-Pedregal is now a research collaborator associate to the Vázquez-Vázquez group.

3.1.1 Recruitment Policy

CiQUS is firmly convinced that the capability to strengthen our capacities and develop our research program in terms of excellent research deeply relies on the quality of our group leaders and students.

As a research centre that belongs to the University of Santiago de Compostela, CiQUS recruiting strategy to attract new talent as Research Staff is governed by the legal framework of the University access regulation.

Every year, we endeavour to use all available tools to recruit the best researchers. In this context, CiQUS has implemented a number of initiatives to attract researchers at different levels. Some of these actions are detailed below.

- **Senior and *Ramón y Cajal* researchers:**

Every year, CiQUS offers positions for **Ramón y Cajal** Researchers, with a special emphasis on topics that need to be strengthened, as suggested by the External Scientific Advisory Board. Over the last 6 years, the recruitment of excellent researchers through this highly competitive program (four of them with no previous relationship with CiQUS) has been clearly successful.

After the appointment of M. Fañanás (2012 call, PhD in Chemistry from the University of Oviedo), J. Montenegro (2013 call) and P. del Pino (2015 call, PhD in Physics, Technische Universität München), CiQUS recruited Dr. María del Carmen Giménez López (2016 call, PhD in Chemistry from the University of Valencia) and Dr. Rebeca García Fandiño (2016 call) in 2018. As a result of the 2017 *Ramón y Cajal* call, a new RyC researcher was recruited in 2019:

- *Dr Beatriz Pelaz* (ranked 3rd in the Chemistry panel): European PhD degree from the University of Zaragoza (2012) and over 5 years of postdoctoral experience at the Philipps Universität-Marburg (Germany) (supervisor: Prof. W. J. Parak). Dr. Pelaz is an expert on the design of novel nanoparticle materials with biological and medical applications and will strengthen the area of Biological and Medicinal Chemistry at CiQUS.

It is worth mentioning CiQUS' commitment to attract and retain young talent and achieve a gender balance as shown by the fact that our three last recruited researchers were female. In this context, it is also worth mentioning that Dr. María Tomás Gamasa (former "*Juan de la Cierva-Incorporación*" postdoctoral researcher at CiQUS) received a grant in 2019 for a very competitive Retos-JIN project to lead a research line in "Biorthogonal Photocatalysis mediated by Visible Light". These Retos-JIN projects are funded by the Spanish Government and offer support to young promising researchers to start their independent career. This project has allowed Dr. María Tomás to continue developing her research career at CiQUS.

- **Postdoctoral researchers and PhD candidates:**

- *The "Juan de la Cierva - Incorporación contracts"* (call 2017) led to the recruitment of two talented young researchers as postdoctoral associates in March 2019: Dr. Marc Font (supervisor: J.L. Mascareñas) and Dr. Fátima García (supervisor: D. Peña).

- Xunta de Galicia postdoctoral Contracts – "A" Mod.: Dr. Andrés Seoane (supervisor: J.L. Mascareñas) and David Ferro (supervisor: A. Fernández-Ramos) returned to CiQUS in July 2019 to complete the second step of their postdoctoral contracts after spending a two-year period at the University of California, San Diego (USA) and University of Porto (Portugal), respectively.

- *CiQUS Predoctoral Contracts*: CiQUS launched the second call of its predoctoral contracts programme at the end of 2018. This program was designed to provide support to excellent CiQUS research groups which might be temporarily under funding shortages. This programme offers a one-year, non-extendable, full-time

employment contract to CiQUS PhD candidates on their first or second year of doctoral studies, in order to keep the scientific production of research groups that might temporarily have problems to fund good PhD students. Those research groups awarded with one of these contracts must seek funding to cover the rest of their doctoral period. CiQUS internal advisory board assessed the applications received and three PhD candidates were finally hired under this call: David Reza (supervisor: J.C. Estévez), Elena Rivadulla (supervisor: Emilio Quiñoá) and Nuria Vázquez (supervisor: Martín Fañanás-Mastral). This programme is funded by the Galician Singular Research Centres Network (Centro singular de investigación de Galicia accreditation 2016-2019, ED431G/09) and the European Regional Development Fund (ERDF).

- **Master students:**

- *Research initiation contracts for CiQUS Master Students:* 12 part-time contracts were offered during the year 2019 for the development of a Master Research Project under the supervision of CiQUS Research Staff (2 contracts more than those that were offered in previous editions). This program aims to help our MSc students at this early stage of research, usually uncovered by state fellowships. Additionally, it also helps to attract young talent with no previous relationship with the University of Santiago.

- **Undergraduate students:**

- *5th Ed. of the CiQUS Summer Fellowships program:* up to 15 scholarships were awarded to highly motivated undergraduate students with excellent academic records, giving them the opportunity to achieve their first research experience, working with CiQUS research groups in first class labs. For the first time, the application process was coordinated by the University of Santiago de Compostela Service for R&D Human Resources Calls. A total number of 29 applications were received from 14 different universities and 7 different countries. The average mark of the selected candidates was above 8.23 on a scale 0-10. It's worth mentioning that 60% of the fellowships were awarded to women. Furthermore, 5 of them were studying for a bachelor's degree in Chemistry, 4 for a double bachelor programme in Biology & Chemistry, 3 for a double bachelor programme in Physics and Chemistry, 2 for a bachelor's degree in Pharmacy and 1 for a bachelor's degree in Biotechnology. This program was co-funded by a special agreement with the Consellería de Educación, Universidade e Formación Profesional of the Xunta de Galicia and by a Contract-Program of the USC and the Santander Bank Universities Foundation.



CiQUS advertising material for the 2019 Summer Fellowship Call and Research Initiation Contracts for CiQUS Master Students (Call 2019) & CiQUS Fellowships holders 2019

Table 1: List of students awarded with a CiQUS Fellowship 2019

Name	Bachelor's Degree	University
<i>Conde Torres, Daniel</i>	Physics & Chemistry	USC
<i>Echavarri de Miguel, Marta</i>	Pharmacy	Complutense de Madrid
<i>Eiroa Osoro, Mateo</i>	Pharmacy	USC
<i>Esperón Abril, Iria</i>	Biology & Chemistry	USC
<i>García Gallardo, María</i>	Chemistry	Valladolid
<i>Giráldez Martínez, Jesús</i>	Physics & Chemistry	USC
<i>Huertas Morales, Iván</i>	Chemistry	Málaga
<i>Martínez Alonso, Carmen</i>	Chemistry	Burgos
<i>Mato González, Sara</i>	Biology and Chemistry	UDC
<i>Moldes Plaza, David</i>	Chemistry	Valladolid
<i>Mosquera Lois, Irea</i>	Chemistry	USC
<i>Pérez Gomes-Ortigao, Susana</i>	Biology & Chemistry	USC
<i>Rivadulla Costa, Laura</i>	Biology and Chemistry	UDC
<i>Suárez Rodríguez, Manuel</i>	Physics and Chemistry	USC
<i>Valderas Gutiérrez, Julia</i>	Biotechnology	Granada

In July 23rd, the 15 summer fellowship holders participated in a mini symposium that took place at CiQUS seminar room. Everyone gave a 5 min talk to the rest of the CiQUS researchers (directors, Research Staff, postdoctoral researchers, PhD candidates, etc), based on the research project that they were collaborating with during their stay at CiQUS. It is worth mentioning the high level of the presentations made by the scholarship holders and the good atmosphere of the scientific discussion.

Once the program was finished, a survey was sent to the scholarship holders through the link: <https://forms.gle/PapYkRQaiozN7MjC6>

The results of the survey show that, in this edition, the program received an overall score of 8.82 points out of 10.

3.1.2 Human Resources Competitive Public Funding

Several grants have been awarded to young **postdoctoral** researchers in 2019 to carry out their research activity at CiQUS:

- *Marie Skłodowska-Curie Actions*: Dr. Ignacio Insua [currently, “Juan de la Cierva-Formación” postdoctoral researcher at CiQUS (supervisor: J. Montenegro)] was granted with a MSCA-IF-ST in January 2019. The associate research project at CiQUS is expected to start in September 2020.
- The result of the 2018 “Juan de la Cierva – Incorporación” call (September 2019) will lead to the recruitment of Dr. Andrea Barba (expected to join CiQUS in Spring 2020; supervisor: J. Montenegro) and the continuation of Dr. Andrés Seoane [currently, “Xunta de Galicia” Postdoctoral researcher (supervisor: J.L. Mascareñas)] as postdoctoral research associates at CiQUS, respectively.
- 1 Young researcher was awarded with a Juan de la Cierva - Formación Contract (Call 2018, Results of the call: September 2019): Dr. Alejandro López (supervisor: M. Giménez López).
- Particularly remarkable is the number of proposals by CiQUS researchers awarded with a “Xunta de Galicia postdoctoral contract” in 2019. Up to 4 researchers will continue their scientific career thanks to this program: David Fernández (supervisor: J.L. Mascareñas), Rafael Rodríguez (supervisor: E. Quiñoá), Iván Varela

(supervisor: J.L. Mascareñas), Marta Castiñeiras (supervisor: A. Fernández-Ramos). Initially, they will spend two years in a research institution abroad (USA, France, The Netherlands and Germany, respectively) and, later on, they will come back to CiQUS for an additional year.

With regard to **predoctoral** trainees and master students, thirteen new competitive research contracts have been awarded to CiQUS PhD students in 2019:

- *MECD – FPU Predoctoral fellowships*: Aitor Álvarez (supervisor: P. del Pino), Daniel Marcos (supervisor: J.L. Mascareñas), Marta Pérez (supervisor: B. Pelaz), Alicia Rioboo (supervisor: J. Montenegro).
- *AEI Predoctoral Contracts (former FPI)*: Núria Vázquez (supervisor: M. Fañanás-Mastral) and Giulia Salluce (Supervisor: J. Montenegro).
- *Xunta de Galicia – Predoctoral contracts*: Alfonso Bayón (Supervisor: J. Montenegro), Eduardo Da Concepción (supervisor: J.L. Mascareñas), José Manuel González (supervisor: J.L. Mascareñas), María Victoria López (supervisor: J. Granja), Marcelo Osorio (supervisor: M. Giménez-López) and Francisco Rey (supervisor: E. Quiñóá).
- *Gil Dávila Foundation: Charlene Harriswangler* (supervisor: J. Montenegro)

Competitive Predoctoral Fellowships and Contracts awarded in 2019		
Program	Institution	No. grants awarded
Gil Dávila Predoctoral Grant	Gil Dávila Foundation	1
Xunta de Galicia – Predoctoral contracts	Xunta de Galicia	6
MECD – FPU	AEI	4
AEI Predoctoral Contracts (former FPI)	AEI	2
		13

Competitive Postdoctoral Contracts awarded in 2019		
Program	Institution	No. contracts awarded
MSCA	MSCA Action (REA)	1
Juan de la Cierva - Incorporación	AEI	2
Juan de la Cierva - Formación	AEI	1
Xunta de Galicia – Mod. A	Xunta de Galicia	4
		8

Ongoing Competitive Contracts 2019		
Program	Institution	No. contracts awarded
Ramón y Cajal	AEI	6
Juan de la Cierva Incorporación	AEI	5
Juan de la Cierva Formación	AEI	4
MSCA Fellowships- Marie Skłodowska-Curie Actions	European Union	3
Xunta de Galicia – Mod. A	Xunta de Galicia	8
Xunta de Galicia – Mod. B	Xunta de Galicia	2
MECD - FPU	AEI	12
AEI Predoctoral Contracts (former FPI)	AEI	16
Xunta de Galicia - Predoctoral Contracts	Xunta de Galicia	21
Fundación Gil Dávila	Fundación Gil Dávila	2
		79

In addition to these new competitive fellowships, an important number of research contracts have been drawn in 2019 under different funded research projects and contracts.

It is worth mentioning that, in 2019, **up to 79 researchers were funded by competitive public programs** (over 40% of CiQUS researchers).

Overall, CiQUS has maintained an increasing capacity to attract young researchers, especially predoctoral students.

3.2 Research Funding

- In 2019, new funding reached 5.6 M € (23% international projects, 17% national projects, 35% regional projects, 20% contracts & valorisation projects and 5% correspond to special agreements with the Regional Government)
- 1 ERC-PoC. 2 IGNICIA Valorisation Projects.
- In addition to its success in the national programs, CiQUS also obtained 2 predoctoral contracts.

CiQUS has proved to have an excellent fundraising capacity despite the difficult financial circumstances, increasing not only the regional and national funds but also international funding. Quite remarkable is also the increase observed in the funds for R&D services and valorisation projects both from private and public sources. This trend clearly shows CiQUS' commitment to strengthen its knowledge transfer capacity. Our figures as at 31st December 2019 show 53 active projects and 12 contracts for a total amount of 14.7 M €.

With regard to new funds raised in 2019, **CiQUS started 27 new projects and signed 8 new contracts for a total amount of 5.6 M €**, (23% international projects, 17% national projects, 35% regional projects, 20% contracts & valorisation projects and 5% correspond to special agreements with the Regional Government), highlighting the balanced distribution between funding sources.

Additionally, a significant increase of budget raised from public sources for funding valorisation projects is observed in 2019. In this context, CiQUS PIs were granted with an ERC-Proof of Concept and 2 IGNICIA projects for a total amount of 0.96 M €.

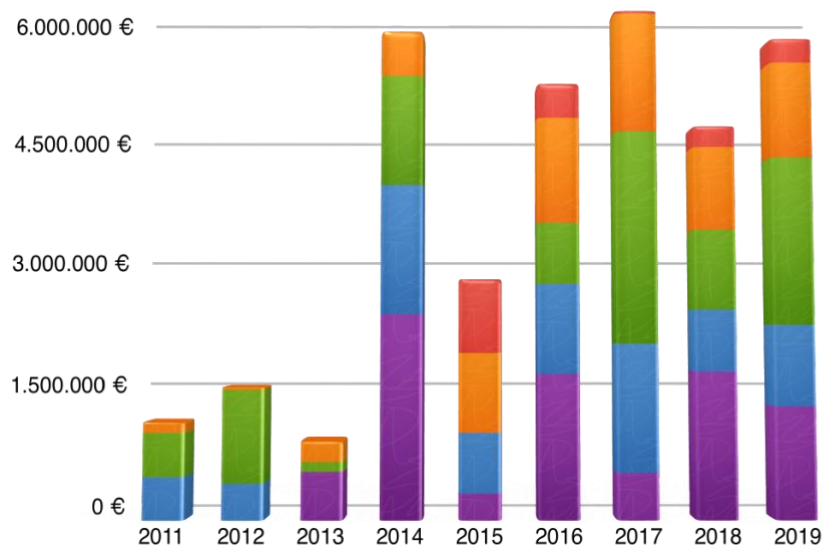
A retrospective analysis over the past five years shows a remarkable and stable fundraising capacity in terms of international budget, specially from the European Research Council (ERC). Since 2014, CiQUS PIs have been granted with 7 ERCs (1 AdG, 1 CoG, 2 StG and 3 PoC). Currently, an ERC-StG application proposal (Dr. B. Pelaz) and an ERC-Synergy proposal have been selected for Step 2 of the evaluation corresponding evaluation processes. Furthermore, CiQUS PIs have also participated in several international collaborative projects over the past years (FET-Open, HFSP, H2020-Societal Challenges...).

The following table and chart show the increasing fundraising capacity of the CiQUS since its opening in 2011. More detailed information regarding 2019 is shown in Annex II and Annex III.

Table 5. R&D fundraising evolution at the CiQUS since 2011

	2011	2012	2013	2014	2015	2016	2017	2018	2019
International Projects	-	-	553.934 €	2.356.276 €	307.391 €	1.670.215 €	538.384 €	1.697.791 €	1.298.236 €
National Projects	494.890 €	420.030 €	-	1.503.409 €	689.620 €	1.038.717 €	1.480.724 €	715.488 €	936.890 €
Regional Projects	504.000 €	1.069.842 €	112.200 €	1.281.000 €	-	709.767 €	2.470.000 €	926.000 €	1.950.000 €
Contracts & Valorisation Projects	119.100 €	28.000 €	238.877 €	527.160 €	914.877 €	1.229.274 €	1.393.821 €	966.598 €	1.117.730 €
Regional Agreements*	-	-	-	-	850.000 €	401.250 €	30.000 €	243.878 €	279.900 €
TOTAL (€)	1.117.990 €	1.517.872 €	905.011 €	5.667.845 €	2.761.888 €	5.049.223 €	5.912.929 €	4.549.755 €	5.582.756 €

(*) Regional agreement refers to specific non-competitive Regional funding link to ERC-grantees Program and Centro Singular de Investigación do SUG accreditation.

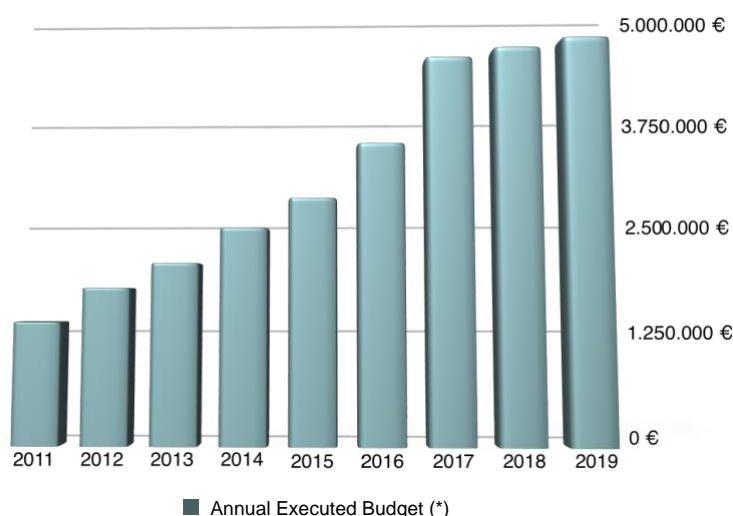


■ International Projects ■ National Projects ■ Regional Projects ■ Contracts & Valorisation Projects ■ Regional Agreements

Chart 3. Evolution of the fundraising capacity, 2011-2019 (*)

(*) HR Programs and Overheads are not included in this chart

Additionally, it is also worth mentioning CiQUS fundraising capacity in terms of annual implemented budget.



■ Annual Executed Budget (*)

(*) HR Programs and Overheads are not included in this chart.

Chart 4. Evolution of the annual implemented budget, 2011-2019

Since its creation in 2011, CiQUS annual implemented budget has continuously increased from 1.4 M € up to 4.6 M €, which represents an increase of 229% since 2011.

Regarding the projects awarded in 2019, these are the key facts:

- **International Projects: 1.30 M €.** The year 2019 has been especially successful in terms of new international projects. Prof. E. Fernández-Megía started the project “ENDOSCAPE”: a clinically applicable non-viral gene delivery technology (RIA-H2020-SC1-BHC-09-2018), a collaborative project with colleagues from many different countries funded by the European Union (RIA-H2020-SC1-BHC-09-2018). Prof. D. Peña and colleagues were granted with a FET-Open project funded by the Research European Agency (REA) [SPRING: Spin Research IN Graphene], that involves the participation of researchers from nanoGUNE, IBM Research, TU Delft, Oxford University, CIPC and CiQUS-USC. J. Montenegro started his ERC-PoC [TraffikGene] and Dr. P. del Pino leads a collaborative POCTEC project (21QBIONEURO), and R&D research network in biological chemistry for the diagnosis and treatment of neurological diseases.

Remarkably, 2 new ERC grants were awarded to CiQUS PIs at the end of 2019 and the beginning of 2020, respectively: Dr. M. Fañanás-Mastral was awarded an ERC-CoG (BECAME: Bimetallic catalysis for diverse methane functionalisation, expected to start in fall 2020). This represents the first ERC Consolidator at the University of Santiago de Compostela and the second one awarded to a researcher working in Galicia. Moreover, Prof. J.L. Mascareñas was awarded with and ERC-PoC (antiCSC, expected to start in autumn 2020). This is the second ERC-project granted to Prof. Mascareñas.

Additionally, Dr. P. del Pino participates in the HeatNMof project, the first research exchange network (MSCA-ITN) with participation of CiQUS PIs, which is expected to start in Spring 2020. Additionally, Prof. Rivadulla will supervise at CiQUS a new Marie Curie Individual Fellowships (MSCA-IF-EF) granted in January 2020.

Finally, a number of highly competitive projects have been submitted to different international calls and are still under evaluation. In particular, an ERC-StG proposal led by Dr. Beatriz Pelaz has been selected for passing to the Step 2 of the evaluation and an ERC-Sinergy (CiQUS PI. Diego Peña) is currently at the second step of the 3 steps of the evaluation's process.

- **National Projects: 0.94 M €.** CiQUS researchers successful competed in the National Research Program (6 projects: 5 of them associated with the RETOS (societal challenges) call and 1 of them associated to the GENERACIÓN DE CONOCIMIENTO call, both of which work in a 3- or 4-year cycle. It is worth mentioning that one of the RETOS projects belongs to the JIN category, a specific topic for supporting young talent researchers without a permanent position at any institution. The PI of this project is Dr. María Tomás Gamasa, former “Juan de la Cierva - Incorporación” postdoctoral researcher at CiQUS. This project will allow Dr. M. Tomás to cover her own salary for the next 3 years and start an independent research line based on Biorthogonal photocatalysis mediated by Visible Light. In addition to these funds, 2 of these projects were also awarded with one predoctoral fellowship.

The national funding also included the young talent incorporation programs Ramón y Cajal (awarded to Dr. Beatriz Pelaz) and Juan de la Cierva Incorporación (awarded to Dr. Marc Font and Dr. Fátima García).

It must be highlighted that a project led by Prof. J. Martínez-Costas (*Development of a vaccine against SARS-VOC-2 by means of muNS-Mi micro / nanospheres*) has just been selected for funding by the Institute of Health – Carlos III (ISCIII) and the Spanish Government within the framework program of “*Extraordinary Funding for Research Projects on Sars-Voc-2 and Covid-19 Disease*” (April 9, 2020). This is the **first project at the University of Santiago de Compostela and Galicia Region that will be funded by the ISCIII to investigate against Covid-19 disease.**

Finally, up to 15 project proposals have been submitted by CiQUS researchers to the “RETOS”, “Generación de Conocimiento” or JIN calls launched by the Spanish Government (Agencia Estatal de Investigación – AEI) last autumn (2019). Results of these calls are expected as of autumn 2020.

- **Regional Funding: 1.95 M €.** 41% (800 K €) accounts for the support of the Xunta de Galicia to the CiQUS as a *Singular Research Centre* of the Galician University System (SUG), co-funded by the European Regional Development Fund – (ERDF), project ED431G/09. Additionally, CiQUS Researchers were granted with up to 6 projects from competitive calls launched by the Regional Government for a total amount of 1.1 M €.

- **R&D contracts and Valorisation projects: 1.1 M €.** In 2019, CiQUS attracted a significant income from valorisation projects funding from public sources through different competitive calls. Dr. J. Montenegro was granted with an ERC-PoC (TraffikGene) for starting the valorisation of the results obtained under his ERC-StG (DyNAP). 2 Projects [RuCSC (Prof. J.L. Mascareñas) and Fluorotools (Prof. E. Sotelo), respectively] have been selected by GAIN (Galician Innovation Agency – Xunta the Galicia Government) for funding within the IGNICIA project. A specific call launched to support the valorisation phase of promising research innovative technologies. Moreover, it is worth mentioning that CiQUS researchers signed 10 R&D contracts during 2019 (0.16 M €) with different companies.

- **Scientific and Technical Equipment: 0.42 M €.** In 2019, CiQUS received funding for the acquisition of a spectroscopy equipment comprising a UV-Vis-NIR spectrophotometer and high sensibility and extended range spectrofluorometer and a hyperspectral image platform (HSI) for fluorescence microscopy through the competitive public call launched by the Spanish Government. It is expected that the new equipment will be installed at CiQUS in autumn 2020.

Finally, it is also worth noting the income associated to the contracts of some of CiQUS researchers (e.g. RyC researchers, JdC postdoctorals; MSCA postdoctoral researchers and predoctoral researchers from regional and national calls) awarded through Human Resources Competitive public calls. In 2019, CiQUS raised up to **1.73 M €** through different **competitive HHRR calls**.

3.3 Research Output

3.3.1 Scientific publications

CiQUS maintained a good record of scientific contributions in 2019, with **89 articles**, 87 of which were published in JCR Journals (98% of all CiQUS publications). **79% of CiQUS JCR articles were published in journals indexed in the first quartile (Q1)** and, more significantly, **42% in the first decile (D1)** of their respective thematic areas of the Web of Science database (WoS) (see Annex IV). In 2019, the **average impact factor of CiQUS JCR articles was 7.67**, thus keeping the remarkable rising trend from the last 5 years.

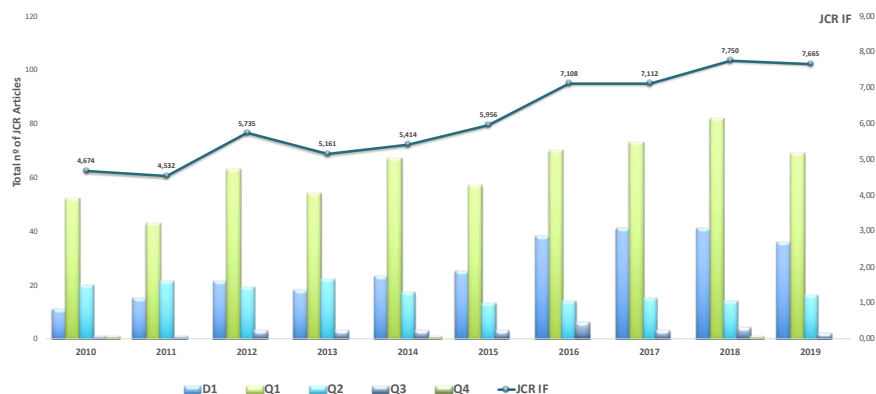


Chart 6. Evolution of the number of publications and average impact factor (*) 2010-2019.

(*) Journal Impact factor values for the year 2019 are based on 2018 Journal Citation Reports (2018 data). 2019 data have not yet been published.

Furthermore, the CiQUS has achieved a sharp increase in the number of publications in top-ranked journals. In 2019, CiQUS published a total number of **28 papers with IF>9**, which represents 32% of CiQUS JCR publications in 2019.

Table 6. Scientific Journals with IF > 9, in which CiQUS articles were published during 2019 and total number of articles per Journal

Full Journal Title	Impact Factor (*)	Nº of articles
<i>Science</i>	41.037	1
<i>Accounts Chemical Research</i>	21.661	2
<i>Advanced Functional Materials</i>	15.621	1
<i>Journal of the American Chemical Society</i>	14.695	6
<i>ACS Nano</i>	13.903	1
<i>Nano Letters</i>	12.279	2
<i>Angewandte Chemie International Edition</i>	12.257	6
<i>Nature Communications</i>	11.878	2
<i>Nucleic Acids Research</i>	11.147	1
<i>Small</i>	10.856	1
<i>Chemistry of Materials</i>	10.159	1
<i>Chemical Science</i>	9.556	4

28

(*) Journal Impact factor values for the year 2019 are based on 2018 Journal Citation Reports (2018 data). 2019 data have not yet been published.

Table 7 shows the list of scientific journals in which CiQUS articles were published in 2019. These journals are listed according to the total number of CiQUS articles published in each journal during 2019 and the corresponding journal impact factor order.

Table 7. Scientific Journals in which CiQUS articles were published during 2019 and total number of articles per Journal.

Full Journal Title	Journal Impact Factor (*)	Nº of articles
<i>Angew. Chem. Int. Ed.</i>	12.257	6
<i>J. Am. Chem. Soc.</i>	14.695	6
<i>Chem. Sci.</i>	9.556	4
<i>J. Org. Chem.</i>	4.745	4
<i>Org. Chem. Front.</i>	5.076	3
<i>Org. Lett.</i>	6.555	3
<i>ACS Appl. Mater. Interfaces</i>	8.456	2
<i>ACS Omega</i>	2.584	2
<i>Antimicrob. Agents. Ch.</i>	4.715	2
<i>Chem. Commun.</i>	6.164	2
<i>Chem. Eur. J.</i>	5.16	2
<i>ChemBioChem</i>	2.593	2
<i>Int. J. Mol. Sci.</i>	4.183	2
<i>Nano Lett.</i>	12.279	2
<i>Nat. Commun.</i>	11.878	2
<i>Org. Biomol. Chem.</i>	3.49	2
<i>Acc. Chem. Res.</i>	21.661	2
<i>J. Mol. Liq.</i>	4.561	2
<i>Appl. Mater. Today</i>	8.013	2
<i>ACS Nano</i>	13.903	1
<i>Adv. Funct. Mater.</i>	15.621	1
<i>Biomacromolecules</i>	5.667	1
<i>Chem. Mater.</i>	10.159	1
<i>ChemCatChem</i>	4.495	1
<i>ChemPhysChem</i>	3.075	1
<i>Curr. Opin. Colloid Interface Sci.</i>	6.271	1
<i>J. Med. Chem.</i>	6.054	1
<i>J. Nanobiotechnol</i>	5.345	1
<i>J. Phys. Org. Chem.</i>	1.53	1
<i>Langmuir</i>	3.683	1
<i>Materials</i>	2.972	1
<i>Molecules</i>	3.06	1
<i>Nanoscale</i>	6.97	1
<i>Phys. Chem. Chem. Phys.</i>	3.567	1

Full Journal Title	Journal Impact Factor (*)	Nº of articles
<i>Polym. Chem.</i>	4.76	1
<i>RSC Adv.</i>	3.049	1
<i>Sci. Rep.</i>	4.011	1
<i>Science</i>	41.037	1
<i>Small</i>	10.856	1
<i>APL Mater.</i>	4.296	1
<i>Adv Therap.</i>	No JCR	1
<i>Talanta</i>	4.916	1
<i>J. Raman Spectrosc.</i>	2.809	1
<i>Colloid Surf. B-Biointerfaces</i>	3.973	1
<i>Curr. Opin. Pharmacol.</i>	5.203	1
<i>Anal. Biochem.</i>	2.507	1
<i>Phys. Rev. Applied</i>	4.532	1
<i>MedChemComm</i>	2.394	1
<i>Pharmaceuticals</i>	No JCR	1
<i>Org. Process Res. Dev.</i>	2.739	1
<i>J. Chem. Edu.</i>	1.793	1
<i>J. Control. Release</i>	7.901	1
<i>Nucleic Acids Res.</i>	11.147	1
<i>Front. Pharmacol.</i>	3.845	1
<i>Faraday Discuss.</i>	3.712	1
Total		89

(*) Journal Impact factor values for the year 2019 are based on *2018 Journal Citation Reports (2018 data)*. 2019 Data have not yet been published.

It is very important to note that many of the publications in top journals are the result of research carried out exclusively in the centre, which demonstrates that CiQUS groups can themselves be highly competitive, and do not depend on others. Also, there is a progressive increase in publications arising from internal collaborations.

However, we are firm believers of scientific collaboration to pursue cutting-edge challenges. Therefore, 48% of the contributions during the period of reference involve international collaborations, many of them with prestigious research centres and groups. It is also true that, in most of them, the main corresponding author is also from CiQUS. **Annex IV** shows a full listing of the scientific articles in JCR journals published by CiQUS researchers in 2019.

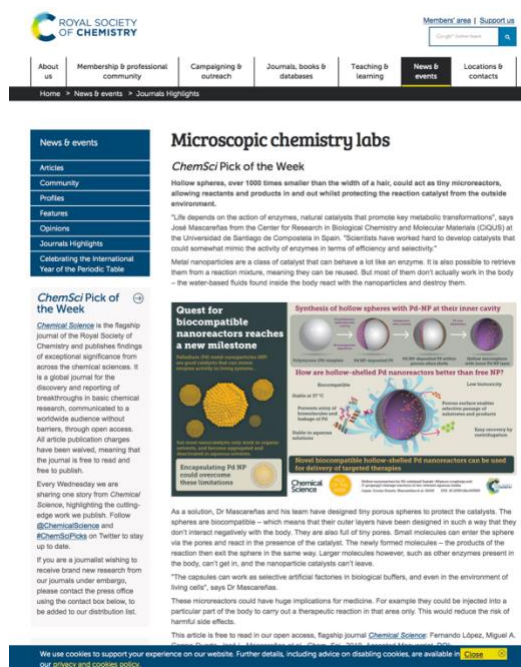
Finally, in line with the commitments of the National and European R&D funding agencies regarding Open Access policy, CiQUS, in collaboration with the USC library, supports its researchers in archiving their scientific production in the institutional online repository of the University of Santiago de Compostela (Minerva). Nowadays, over 60% of CiQUS whole production is archived in Minerva. Furthermore, according to Web of Science database, over 44% of CiQUS scientific publications published by CiQUS researchers in 2019 were already Open Access articles through the corresponding journals.

3.3.2 CiQUS Scientific highlights

Among the most outstanding scientific findings in 2019, there are contributions from the three priority thematic areas of CiQUS. Many of the articles were highlighted by journals themselves by including them within special thematic issues. Some examples are the *Angewandte Chemie International Edition* (DOI: 10.1002/anie.201811747) “Rhodium-catalyzed annulation of ortho-alkenylanilides with alkynes: Formation of unexpected naphthalene adducts” published by Prof. Mascareñas and Prof. Gulías that was selected as Hot Topic in C-H activation and the review “Where in the cell is our cargo? Current methods to study intracellular cytosolic localization” published by Dr. Montenegro in the *ChemBioChem Journal* that was selected by the editor as Hot Article in Drug Delivery. Regarding the thematic area of functional materials it is worth mentioning the article “Kekulene Revisiting: Synthesis and Single-Molecule Imaging” (DOI: 10.1021/jacs.9b07926), published in the *Journal of the American Chemical Society* by professors Dolores Pérez, Diego Peña and Enrique Guitián in collaboration with the research group Leo Gross at IBM Research Zurich (Switzerland) and with the computer support of Manuel Melle-Franco at the University of Aveiro (Portugal). The researchers were able to re-isolate this iconic compound and, for the first time, visualize its structure with atomic resolution, using the Atomic Force Microscopy (AFM) technique. This article, which has over 6,600 views, has also had a major impact on social media, reaching an altmetrics of 126, which places it among 5% of the most impactful research results. The article was highlighted by numerous media and scientific blogs both nationally and internationally (In the Pipeline, Chemistry views, Chemistry World, NCYT, madri + d, El Correo Gallego, GaliciaPress, SusChem-ES, etc).

The article published by Prof.'s Mascareñas Group in collaboration with Miguel A. Correa-Duarte's group at the CINBIO (University of Vigo Centre for Biomedical Research) in the journal *Chemical Science* - “Hollow nanoreactors for Pd-catalyzed Suzuki – Miyaura coupling and O-propargyl cleavage reactions in bio-relevant aqueous media” (DOI: 10.1039 / C8SC04390F) should also be highlighted. This joint research led to the creation of new spheres porous up to 1,000 times smaller than a hair, which allow the permeability of molecules between the inside and the outside and, at the same time, protect the catalyst from its surroundings, allowing reaction in its indoor space. These microreactors have promising applications in the field of medicine. If injected, for example, at a specific site of the body, they could carry a chemical reaction directed only to the affected area, thus reducing the risk of harmful side effects in therapeutic treatments. This article has been selected by the Royal Society of Chemistry editorial for the thematic collection: 2019 Chemical Science HOT Article Collection. In addition, the same scientific journal 'Chemical Science' highlighted the article in its section of Pick of the Week, a section in which those responsible for publishing, select and promote each week the most relevant work for sharing it with the global chemical research community.

Finally, it is also worth mentioning the article published in *Science* “Molecular structure elucidation with charge-state control” (DOI: 10.1126/science.aax5895) by Prof. D. Peña. It is a collaborative project with researchers from IBM Research–Zurich and ExxonMobil Research and Engineering Company (USA) in which high-resolution atomic force microscopy (AFM) was used to control and image the charge state of organic



molecules adsorbed on multilayer sodium chloride films. This is the second *Science* publication by Prof. Peña in the last 2 years.

Additionally, these findings and other relevant announcements were disseminated by the Singular Centres communications office through the centre's website (news section), social networks (Twitter, Facebook, Youtube, LinkedIn and Google+) and, in some cases, through the press media.

A complete list of articles, with links to their respective journal websites, can also be found in [CiQUS web page](#). Additional information about the selected articles, considered as significant scientific contributions of that period, can be found in the *News* section of the website (<https://www.usc.es/ciqus/en/news>).



3.3.3 Other research outputs

• Patent applications

In 2019, CiQUS researchers filed a new Spanish patent application: Cx43 peptide fragments for use as senolytic agents (PI. José L. Mascareñas and Eugenio Vázquez). Additionally, they also filed 6 applications belonging to 2 patent families which entered national phases (USA, CAN, MX, JP, AU and IT): Ruthenium complexes for treating cancer (PI. José L. Mascareñas and Eugenio Vázquez) and Iron oxide nanocubes for tumour targeting (PI. Juan Granja). Finally, three new PCT procedures were also initiated during the same year.

• PhD Theses

In 2019, up to 23 CiQUS graduate students presented their PhD theses. All of them obtained a *Sobresaliente cum laude* qualification and 14 of them obtained a *European doctorate/International Mention*; 9 of the new doctors were female (39%) and 5 of them were international trainees (22%). One of these theses was co-supervised with the University of Nantes (France) (Joint PhD Program). Detailed information about CiQUS PhD theses presented in this period can be found in Annex V and on [CiQUS website](#). These graduate students received external financial support either from competitive research fellowships or through contracts linked to their advisor's research grants.

Currently, 91 PhD students are developing their thesis work at CiQUS. 10% of students come from abroad and 46% are female.

• *Contributions to scientific congresses*

CiQUS Research Staff gave over 35 lectures in 2019. **10 of them as Plenary, 5 as Keynote and 20 as Invited Speakers** at international conferences and meetings from 11 different countries (USA, Germany, France, Spain, Portugal, Bulgaria, Japan, India, Armenia, Cuba and Brazil). Organometallic Catalysis Directed Towards Organic Synthesis (OMCOS)-20 (Germany), Journées de Chimie Organique 2019 (France), Gordon Research Conference Advances in Chemistry and Chemical Biology to Expand the Druggable Proteome (USA), Molecular Chirality Symposium (Japan), International Conference on Chemical Science and Nanomaterials (ICCSN) (India), International Pharmaceutical Conference in Drug Development: from Design to Customer (Armenia). Furthermore, it is worth noting the total number of CiQUS scientific contributions at congresses (148).

• *Organization of scientific congresses and symposiums*

Dr. Javier Montenegro coordinated, together with Dr. Ruth Pérez (CIB-Margarita Salas, Spain), the symposium “Chemical Strategies to Modulate Biological Processes” within the XXXVII Biannual Meeting of the Spanish Royal Society of Chemistry (San Sebastián, Spain). Prof. Eugenio Vázquez organised, together with several other CiQUS PIs (M. Fañanás-Mastral, F. Freire and D. Peña), the “IV QuimBioQuim Meeting” (a specialized congress for young therapeutic chemists and biochemists) that was hosted at CiQUS centre in October 23-25, 2019. CiQUS PIs M. Vázquez-López and F. López were members of the Scientific Committee for this meeting.

• *Research Mobility*

In 2019, up to 14 CiQUS members had short stays at prestigious international research institutions from 8 different countries, either for scientific collaborations (as invited visiting professors) or as part of their PhD training program (predoctoral secondments). Eindhoven University of Technology (The Netherlands), Universidade do Porto (Portugal), California Institute of Technology (USA), University of Lisbon (Portugal), National Institute of Chemistry (Slovenia), Trinity College of Dublin (Ireland), Van't Hoff. Institute for Molecular Science (The Netherlands), Queen's Medical Research Institute – University of Edinburgh (UK), University of California – San Diego (USA), Scripps Research Institute (USA), CRANN/School of Chemistry – Trinity College Dublin (Ireland), University of Angers (France), University of Nantes (France), Harvard University (USA).

3.3.4 Awards

Regarding the awards received by CiQUS Principal Investigators, our researchers received the following awards:

- *Prof. Enrique Guitián*: Distinguished Research Career Award by the Spanish Royal Society of Chemistry 2019
- *Prof. José Luis Mascareñas*: 1st “Antonio Casares Rodríguez” Medal – Galician Royal Academy of Science (Chemistry and Geology Division)
- *Prof. Javier Montenegro*: Young Research Group Leader – Spanish Royal Society of Chemistry (Chemical Biology Division)



Some Awarded CiQUS Researchers in 2019

Regarding CiQUS young researchers, several postdoctoral researchers and PhD candidates have also been awarded in 2019:

- *Iago Pozo* (PhD Candidate - Guitián/Pérez/Peña Group): Poster Award in the 18th International Symposium on Novel Aromatic Compounds (ISNA18, Sapporo, Japan).
- *Marisa Juanes* (PhD Candidate – Granja/Montenegro Group): Best Poster Presentation Award CRSScience (Controlled Science Release Society 2019, Valencia, Spain)
- *Alejandro Gutiérrez* (PhD Candidate – Mascareñas/López/Gulías Group): Flash Presentation Award – XXXVII Bienal RSEQ 2019 (San Sebastián, Spain)
- *Claudia Gioé* (PhD Candidate – Sotelo Group): Best Flash Communication – 19th Meeting of the Spanish Society of Medicinal Chemistry (Vitoria – Spain).
- *Borja Cendón* (PhD Candidate – Mascareñas/López/Gulías Group): Best Short Oral Communication. 6th Barluenga Conference 2019 (Oviedo, Spain).
- *Dr. Ignacio Insua* (Postdoctoral Researcher – Granja/Montenegro Group): Best SUPRABIO 2019 Oral Presenter – International Symposium on Supramolecular Systems (Barcelona, Spain).
- *Dr. Alejandro Méndez* (Postdoctoral Researcher – Granja/Montenegro Group): Royal Society Award – 14th International Symposium on Macrocyclic and Supramolecular Chemistry (ISMCS2019, Lecce, Italy).

3.4 Training

3.4.1 Master

Most of CiQUS PIs participate in the master's degree in Chemical Research and Industrial Chemistry (in collaboration with the University of Vigo and the University of A Coruña) and the Master in Organic Chemistry (with the UCM and the UAM). Their participation in the Master of Theoretical Chemistry and Computational Modelling (Erasmus Mundus) and the Master in Drug Research and Development is also relevant. CiQUS annually offers between 25 and 30 vacancies for the Master Project. Approximately 60-65% of the students for the master's degree in Chemistry from USC are trained at the CiQUS.

Outstandingly, the Master's degree in Organic Chemistry was ranked as the third-best Master's degree in Spain within the category of "Experimental and Technological Sciences", and the best Master in Chemistry according to the ranking annually published by "El Mundo" newspaper (<https://www.elmundo.es/especiales/mejores-masters/ciencias-experimentales-y-tecnologicas.html#quimica-organica>).

It is also very important to note that, in 2019, the new Master's degree program "*Master in Chemistry at the Interface with Biology and Materials Science*" (ChemBio&Mat), promoted by CiQUS and designed and prepared by an academic board composed of CiQUS PIs (from all scientific areas of the centre), got the official approval of the regional and national education authorities to start the first promotion in the academic year 2019/2020. The final approval was confirmed by mid-June, which means that there was less than one month and a half left to carry on with the promotion of this new Master's degree among prospective students. Nevertheless, 10 students enrolled in this first year. Among these students, there are chemists, biologists and physicists from the University of Santiago de Compostela, the University of Coruña and the University of Vigo.

This Master is coordinated by CiQUS PI Prof. Juan Granja. It is a 1.5-year programme (90 ECTS) aimed at providing first-class multidisciplinary training at the frontier of chemistry, biomedicine and materials sciences, from a molecular approach and giving the students the necessary practical skills and knowledge to undertake a professional or a research career.

CiQUS has created a specific website for this Master Programme (<http://masterchembiomat.usc.es>), where visitors have access to complete and detailed information about the academic programme, the Lecturers and many other interesting details. Posters and graphic material were designed for advertising the new Master's Programme. Furthermore, a complete brochure was prepared for the students. This document contains all the relevant information about the ChemBio&Mat Master's degree (it includes Master dissertation project proposals, hosting research groups for performing experimental Master Dissertation, lecturers' biographical sketches, teaching schedules and other info related to the programme).

http://masterchembiomat.usc.es/doc/UNqKFwtexULvG23B/Brouchure_Master_ChemBio_Mat_2019-2020_v2.pdf

Finally, in September 2019, the Master's Degree in Chemistry at the Interface with Biology and Materials Science was launched by CiQUS, the Faculty of Chemistry and the USC for the academic course 2019/2020.



<http://masterchembiomat.usc.es>



90 ECTS
It is a study programme organized in 5 areas (modules)



1.5 YEARS
Programme length: 3 semesters (18 months)



ENGLISH
All courses are taught in English



MULTIDISCIPLINARY
18 Research Groups at CiQUS working in 3 thematic areas: Biological & Medicinal Chemistry; Functional Materials and Synthetic Methodologies



INTERNATIONAL
The teaching staff includes up to 4 ERC grantees (6 ERC Projects) and other internationally renowned scientists



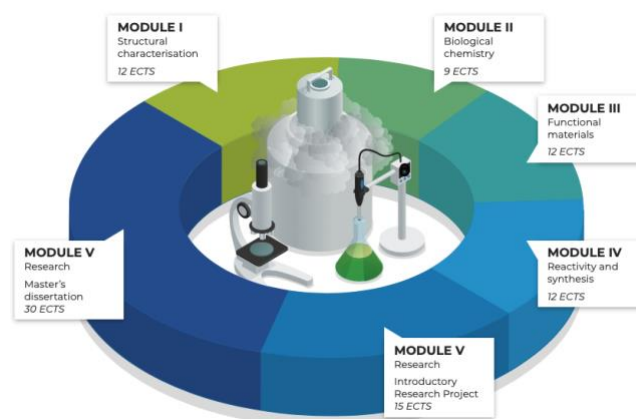
EXPERIMENTAL
Hands-on training in state-of-the-art experimental techniques. Research projects mean 50% (45 ECTS) of the study plan



MOBILITY
Opportunity to do an internship to conduct research in a different Partner institution or company



MENTORING
Academic and industrial supervisors for career advising and professional development



Master's Degree official logo, website and ECTS distribution by thematic modules of the study program

3.4.2 Doctoral programs

One of the major strengths at CiQUS is the successful activity in the training of researchers, both at doctoral and post-doctoral level.

Most of the students (85%) are enrolled in the PhD program in Science and Chemical Technology (Mention of Excellence). Other doctoral programs are Research and Development of Drugs, Materials Science or Biology. Regarding the gender distribution, currently 41% of doctoral students are women. Moreover, it is noteworthy that more than 10% of doctoral students come from abroad.

23 theses were defended by CiQUS students in 2019, all of which obtained *cum laude* top marks. A complete list of theses presented yearly can be found in Annex V.

The excellent training received by our PhD students is remarkable, not only due to the scientific level of most of the research groups of the centre, but also thanks to the stimulating and competitive environment of CiQUS, the biweekly interdisciplinary seminars program or the training in transferable skills. Additionally, our MSc and PhD students, together with the rest of CiQUS members, have the opportunity to attend the CiQUS Lectures Program, with top level international speakers from many different scientific disciplines. (See Annex IX for the complete list of speakers in 2019)

The success of the training activity is evident in the awards and recognitions received by our PhD students (see section 4.3.3) and their success in accessing the best international centres: www.usc.es/ciqus/en/research/docs.

3.4.3 Postdoctoral programs

In 2019, 59 researchers developed their postdoctoral training at CiQUS, 42% were female and 15% of them came from other countries (UK, Italy, The Netherlands, South Korea, Portugal, Turkey, India and Jordan). Regarding gender distribution, 23% of the postdoctoral researchers at CiQUS were female in 2018.

The success in attracting postdoctoral researchers through national and regional competitive calls is also considerable. In particular, the Juan de la Cierva Program allowed the recruitment in 2019 of 3 investigators based on the results of the 2018 Calls (2 of them as Juan de la Cierva Incorporación and another one as Juan de la Cierva Formación), while the postdoctoral grants of Xunta de Galicia (Mod. A) resulted in the recruiting of 4 postdoctoral researchers (currently at the outgoing phase).

3.4.4 Funding for training (grants and contracts)

As previously mentioned, every year CiQUS offers part-time contracts to support the best MSc students, prioritizing those who work in cooperatives or strategic lines (CiQUS Research Initiation Contracts). In 2019, CiQUS made an additional economical effort to support this programme and offered 12 part-time contracts, 2 more than those offered in previous editions. 12 Master students performing their Master Thesis Dissertation at CiQUS were hired under this call (50% were female). 5 students were enrolled in the master's in chemistry at the Interface with Biology and Materials Science, 4 in the Master in Organic Chemistry, 2 in the master's in chemical Investigation Research and Industrial Chemistry and 1 in the Master in Theoretical Chemistry and Computer Modelling.

Regarding the doctoral stage, 50 PhD students were developing their theses supported by competitive national grants and contracts during 2019 (16 AEI Predoctoral Contracts (former FPI), 12 FPU, 21 Predoc by Xunta de Galicia and 1 by private foundations). Most of the remaining doctoral students have contracts linked to research projects. Additionally, 3 CiQUS PhD candidates (first or second year) were hired by a one-year full-time contract within the CiQUS Predoctoral contracts programme.

As far as postdoctoral researchers are concerned, in addition to those hired through national competitive programs (see 4.4.3) and international exchange programs, they all have contracts linked to research projects.

It is worth mentioning the recent success in applying for the Individual Fellowships of the Marie Curie Program (H2020-MSCA-IF). 2 postdoctoral researchers will be hired under the MSCA-IF contracts at CiQUS throughout 2020.

3.4.5 Other training and courses

Throughout the year, CiQUS organises several technical courses to implement scientific skills on the use of different equipment. In 2019, CiQUS hosted specialized training for the use of the HPLC Recycling and on the new GCMS equipment. Additionally, CiQUS members had the opportunity to attend different courses organized by other research centres at the USC (e.g. statistical methods, scientific writing and scientific presentations, patents and IP, etc.).

Additionally, the Deputy Director (Prof. Dolores Pérez) and CiQUS PIs (Prof. E. Vázquez and Prof. D. Peña) attended the specialised course “Strategic Management of Research Centres and Units – GESCI”. At the same time, the head of strategic initiatives (Dr. Almudena García) and the head of knowledge transfer and international affairs (Fernando Casal) attended the specialised course “Operational Management for Research Centres and Units – GOSCI”. Both courses (<https://gesci.es>) were held from September 2018 to March 2019 by the Consellería de Educación, Universidade e Formación Profesional of the Xunta de Galicia in collaboration with FEUGA, a high-level training programme to promote competitiveness, excellence and continuous improvement in the research centres of the Autonomous Community of Galicia.

3.5 Internationalization

- 2019: 49% of the papers include some international collaboration (42% D1, 79% Q1) (WoS database)
- 1 ERC-PoC (TraffikGene), 1 FET-Open (SPRING), 1 Horizon 2020 initiatives (ENDOSCAPE). (Among others, 1 ERC-CoG and 1 ERC-PoC were granted at the end of 2019 and the beginning of 2020, respectively)

CiQUS researchers have demonstrated their commitment with internationalization, both in funding and publications. This section describes the most relevant facts and efforts.

43 papers (48%) resulting from international collaborations (35% in 2011-2014), **74% of them in the first quartile (Q1)** and **43% in the first decile (D1)**. Up to 65% of these works have at least one corresponding author from CiQUS. Among the collaborators, there are a number of research groups from prestigious research centres, including the University of California, San Diego (USA) or IBM Research (CH).

With regards to **international projects**, in 2019 several international collaborative projects have been initiated at CiQUS: The European Collaborative Project “ENDOSCAPE”, in which Prof. E. Fernández-Megía participates as member; Prof. D. Peña and colleagues started their works under the FET-Open project funded by the Research European Agency (REA) [SPRING: Spin Research IN Graphene] and Dr. P. del Pino leads a collaborative POCTEC project (21QBIONEURO, an R&D research network in biological chemistry for the diagnosis and treatment of neurological diseases) with the participation of Prof. Mascareñas, among others. It is highly remarkable that, in 2019 and at the beginning of 2020, CiQUS PIs were also granted with an ERC-Consolidator (BECAME, Dr. M. Fañanás-Mastral), a new ERC-Proof of Concept (antiCSC, Prof. J.L. Mascareñas), a new FET-Open (Dr. B. Pelaz) and Dr. P. del Pino participates as member of a MSCA-ITN project (HeatNMof). All these projects are expected to start at CiQUS throughout 2020.

In 2019, CiQUS received up to 27 visiting researchers (48% female and 89% foreigners) from 10 different countries (Japan, India, Jordan, UK, France, Italy, Argentina, Chile, Venezuela, Spain). They were 3 University Professors, 8 Postdoctoral researchers, 10 PhD candidates and 6 undergraduate students.

Regarding CiQUS PIs, up to 8 were invited professors at different institutions and companies to give a total of 15 seminars and talks related to their research activity. Some of these host centres were Janssen Pharmaceutical (Spain), ICIQ (Spain), ESPCI Paris (France) and EPFL (Switzerland), among others.

European Technology Platforms (ETP). Since 2012, CiQUS is a member of SusChem Spain, which is part of the **ETP for Sustainable Chemistry (SusChem)**. A CiQUS representative has attended almost all its Stakeholder meetings and Brokerage events, including the presentation of project ideas for H2020 (project pitching).

Since 2015, CiQUS also belongs to the **ETP Nanomedicine (ETPN)**. Remarkably, CiQUS has managed the organization and institutional presence (as exhibitor) of the whole USC at NME19, the joint meeting of the 14th annual event of ETPN & the 3rd European Nanomedicine Meeting (ENM) merged into a unique event (June 17-19, 2019, Braga - Portugal).

CiQUS has also joined **MATERPLAT**, the Advanced Materials and Nanomaterials Spanish Technological Platform, attending the Annual Meeting in 2019 (26th November, San Sebastián).

COST Actions. After several years in which CiQUS IPs have been members of a number of Managing Committees, two new COST Actions which included two CiQUS researchers in their original network of proposers have been launched in 2019: CA18133 - European Research Network on Signal Transduction European Research Network on Signal Transduction, and CA18103 - Innovation with Glycans: new frontiers from synthesis to new biological targets.

Since 2012, CiQUS is a member of SusChem Spain, part of the European Technology Platform for Sustainable Chemistry, ETP SusChem. Notably, CiQUS researchers have collaborated widely in the revision of technology priorities covered under the new SusChem Strategic Innovation and Research Agenda (SIRA) 2019.

Throughout 2019, CiQUS attended a number of national and international networking events: RIKEN Europe Office Anniversary Symposium (Brussels), SusChem Stakeholder Event (Brussels), MATERPLAT Platform - Annual Meeting 2019 (San Sebastián), NanoBio&Med 2019 (Barcelona), Horizon 2020 Batteries (London), EU Brokerage KETs NMBP (Strasbourg), Biomedical Innovation Summit (Madrid), NME 2918 – ETP Nanomedicine (Braga), Consortia Brokering Event for H2020 NMBP (London), Successful R&I in Europe - 10th EU Networking Event 2019 (Düsseldorf).

Finally, it is worth mentioning that CiQUS website provides detailed and accessible information about all the activity of the centre, including its scientific production and patents generated, as well as a specific section with the technology transfer offers (www.usc.es/ciqus/en/technology-transfer).

CiQUS Lectures Program. In 2019, up to 31 top level international scientists, including Prof. Ben. Feringa (Nobel Laureate in Chemistry 2016, University of Groningen, The Netherlands), Prof. Luis Echegoyen (Elected President of the American Chemical Society, University of Texas, El Paso - USA) and Prof. Ángel Rubio (Director at Max Planck Institute for Structure and Dynamics of Matter, Germany) and Prof. Gerard Roelfes (ERC grantee, University of Groningen – The Netherlands), among others, were invited to give a talk on their own research fields at CiQUS.

Finally, in 2019, 10% of CiQUS members came from foreign countries (Italy, UK, The Netherlands, France, Greek, Chile, Jordan, South Korea, Turkey, Japan, Indonesia, Cuba, Mexico, Venezuela, and Colombia).

3.6 Technology Transfer and Valorisation

3.6.1 R&D projects in collaboration with companies and entities

During 2019, CiQUS researchers have signed or launched up to 11 new contracts or valorisation projects. Even though the number of contracts decreased significantly with respect to previous years, the total amount has increased a 16% as compared to 2018, adding up to 1.12 M €. Thus, it is worth mentioning that the average value of these contracts increased up to 102,000 €.

The following paragraphs summarize the relevant information about new contracts during 2019.

- **Landsteiner Genmed S.L.** (Sevilla). Following previous agreements since 2018, a new 65,000 € contract has been signed to develop synthetic methodologies and organic molecules libraries.
- **INDITEX** (multinational, A Coruña). A new 68,000 € contract was signed in 2019.
- **MestreLab Research** (Spin-off, Santiago). As part of a long-term relationship, a new 60,000 € contract has been signed to provide support for the development of chemical software.
- **Oncostellae S.L.** (Spin-off, Ourense). A new 22,000 € contract was added to the ongoing 60,000 € contract (2018-2020). This cooperation aims at developing new complementary therapies for the treatment of oncological diseases as well as obtaining libraries of bioactive organic compounds.
- **AMSLab, S.L.** (Spin-off, Lugo). A leader company in the quality control sector with a high level of specialization for developing and improving determination and quantification analytic techniques. A new 18,000 € contract.
- **zLabels GmbH** (multinational, Germany). This company focused on the creation of contemporary fashion brands which sold online via Zalando and other global retailers. 2 contracts totalling 10,000 € were signed in 2019.

Additionally, several other small contracts were also signed during 2019 with Sigillum Knowledge Solutions, ABCR Labs and Ozoaqua, among others. Although the total budget raised thanks to these small contracts is not so remarkable, they are also important in terms of employability. They do not only support innovative SMEs or spin-offs but also open new job positions. In this context, up to 8 CiQUS alumni have been hired by those companies during 2019. It is worth mentioning that many of those R&D contracts arise from the strategic relationship with Inditex in recent years.

The full list of active R&D contracts during 2019 is available in Annex III.

3.6.2 Patents, Licensing and Valorisation Projects

A Spanish patent was granted in 2019: *Cell penetrating peptides* (PI. Javier Montenegro), together with a new application at the Spanish Patent Office: *Cx43 peptide fragments for use as senolytic agents* (PI. José L. Mascareñas and Eugenio Vázquez).

Furthermore, 2 patent families entered national phases. Thus, 6 patents were filed (USA, CAN, MX, JP, AU and IT) to extend the protection of the related patents: *Ruthenium complexes for treating cancer* (PI. José L. Mascareñas and Eugenio Vázquez) and *Iron oxide nanocubes for tumour targeting* (PI. Juan Granja). Finally, three new PCT procedures were also initiated during the same year.

Regarding patent licences, the long-term relationship with an Animal Health Company which licensed two families of patents related to the muNS technology, developed by the Group Benavente – Martínez-Costas

should be highlighted. Based on the initial agreement, new funds (confidential data) have been allocated to the group in 2019 to continue the valorisation works.

In the context of valorisation projects, special emphasis should be placed on two new initiatives granted by the ERC-Proof of Concept scheme, each of them funded with 150,000 €:

- **TraffikGene:** Peptide Dynamic Amphiphiles for Gene Therapy and Macromolecular Delivery (PI. Javier Montenegro)
- **antiCSC:** Targeting the cancer stem cell metabolism with designed, reactive metal complexes), (PI. José L. Mascareñas)

In addition, two important valorisation projects funded by the IGNICIA Programme (Axencia Galega de Innovación – GAIN) were launched in 2019, after a competitive evaluation by experts from Oxford University Innovation.

- **FluoroTools.** Funded with 427,000 €, led by CiQUS IP Prof. Eddy Sotelo together with Prof. Mabel Loza (CiMUS PI) and Prof. Javier Sardina, to develop fluorescent probes for drug evaluation (HTS).
- **RuCSC.** 386,000 €, led by Prof. José Luis Mascareñas for the development of new antitumor products based on targeting stem cells.

With regard to valorisation initiatives, the participation as beneficiary in the project FET-OPEN *Spin Research in Graphene* (PI. Diego Peña), led by CIC nanoGUNE should be pointed out. Starting in 2019, this project aims to test the potential of graphene as a fundamental building block for spintronic devices.

Concerning the generation of spin-offs, the two aforementioned IGNICIA projects (FluoroTools and RuCSC) include entrepreneurship or patent licenses in their budgets and roadmaps.

The start-up company **Sigillum Knowledge Solutions** (<http://sigillumks.com>), promoted by the PI. Prof. Javier Sardina, founded at the end of 2018, has played a key role providing employment opportunities to CiQUS former PhD students and postdoctoral researchers. The company focuses on the growing need of fashion companies to comply with the dynamic international regulations, as well as evaluating the health, safety, quality and sustainability of their products.

Finally, also noteworthy is the entrepreneurship of a former PhD student, Dr. Lionel Ozores, who has been one of the founders of the company Chemosapiens (<https://chemosapiens.com/>).

3.7 Outreach

3.7.1 CiQUS website and presence in the media

CiQUS website (www.usc.es/ciqus/es) is a fully trilingual web page with updated information about research areas, scientific production, research groups, facilities, job offers, training programs and comprehensive information about the centre's activities and research outputs. It is currently complemented with social networks: Facebook (2011), LinkedIn (2012), YouTube (2013), Twitter (2014) and Google+ (2014).

In Spring 2019, CiQUS website underwent a deeply renovation process. Its appearance has been modernized and, from a technical point of view, an adaptive design (web responsive) has been implemented to facilitate its access and correct display from any electronic device (desktops, mobiles and tablets). Additionally, it has been implemented with the creation of new sections that increase the centre's information details available to visitors. Specific sections on transparency, structure and organization, training, fellowships and contracts and CiQUS Lectures have been created. In the same context, the sections that collect the information of the research groups and their corresponding scientific activity have been fully updated. Tracking traffic and web visitors are monitored through Google analytics. As a result of this update, analytic data for the year 2019 are only available from July 2019. CiQUS website has received more than 73,700 visits from July 1st to December 31st, 2019 (data were downloaded in April 11th, 2020). Approximately 46% correspond to new visitors. The majority age range of visitors is between 25 and 34 years old (40%) and 47% are female. CiQUS website has received visits from up to 100 different countries, mainly Spain (80%); USA (3%); Israel, UK, India (2%); Portugal, Germany, France, The Netherlands and Italy (1%). Regarding electronic devices, 60% of the visitors used desktops, 38% mobiles and 2% tablets.

YouTube. Since December 2013, CiQUS started to broadcast a series of divulgation videos made by our Press Manager. Currently, CiQUS YouTube channel has reached over 18,800 visualizations and a total of 300 hours, 48% from outside Spain, e.g. 8% from USA and 4% from UK. We must highlight the outstanding impact achieved by two videos (2015, 2016) by IBM Research (Zurich) with the participation of CiQUS researchers. The second one has over 566,000 views (12,000 during the first 3 weeks) in the **IBM YouTube Channel** (www.youtube.com/watch?v=OOKbt16M3Mg), being among its 40 most watched videos. Obviously, this visibility is an invaluable asset for the CiQUS.

Facebook. 1,686 followers. Currently, around 26% of the posts had over 3,000 impressions according to Facebook statistics, and the top 10% reach more than 5,000 impressions. Considering that CiQUS was created only 8 years ago, our average impact is comparable to the best excellent Spanish research centres, according the comparative provided by Facebook.

LinkedIn. The number of CiQUS followers in LinkedIn has experienced a moderate but steady growth since this profile was created in 2013. It currently has 1,418 followers. However, the most interesting impact is being achieved through posts in the specialized groups, which are used to target specific professional groups, both from the academia and the private sector.

Twitter. 1,651 followers, which means over 40% increase in the number of followers every year: 150 (2014), 388 (2015), 662 (2016) and 818 (2017), 1,180 (2018). Nowadays, it has 1,500 visits and over 40,000 impressions per month.

Since 2013, the incorporation of a **Press manager** (shared with CiMUS and CiTIUS) boosted the impact of CiQUS dissemination, including frequent press releases, which are commonly posted on several international scientific divulgation websites (Nanowerk, Nanotech-Now, TG Techno...) and LinkedIn, as well as the most important national scientific divulgation channels and other divulgation websites, as Agencia SINC, Madrimasd

or Noticias de la Ciencia-NCYT and SusChem Spain Newsletter. Thus, CiQUS has significantly increased its presence and impact in the media.

It is worth mentioning the presence of CiQUS PIs in several national newspapers (La Vanguardia, El Periódico,...) and regional media such as the mainstream newspapers La Voz de Galicia and El Correo Gallego, and specialised webpages such as GCiencia-O Portal da Ciencia Galega or Agencia SINC, Fundación Madri+d and SusChem España Newsletter which regularly include press releases about CiQUS members and CiQUS activity.

Additionally, CiQUS Scientific Director, Prof. José Luis Mascareñas, and CiQUS Deputy Director, Prof. Dolores Pérez, among other CiQUS PIs are regularly broadcast interviewed on the occasion of special events or announcements (Cadena Ser Radio, Galega Radio and regional newspapers).

3.7.2 Outreach and promotion of scientific vocations aimed at students and the general public

The Management and CiQUS members are strongly committed to education and popularization of science. In every academic course, there is a considerable collective effort to organize the CiQUS Open Days Program **"Research in Chemistry: creative science for a better world"**, aimed at high-school students. These actions have the objective of explaining the importance of chemistry in the economic development and welfare of society.

Attendee students had the opportunity to visit the centre, participate in scientific demonstrations, and perform simple experiments such as the preparation of well-known drugs (aspirin, paracetamol), and through these experiments they also learn the most common structural characterization techniques. In 2019, CiQUS organized the 7th Edition of this programme with the participation of over 500 high school students from 25 different centres all around Galicia (from up to 20 different places).

Apart from this programme, during the whole year, CiQUS regularly organizes the visit of groups of students from different schools, high school groups and universities to the centre. More than 200 students from 7 different centres (from primary school to University level) visited CiQUS in 2019 within this programme.

In May 2019, CiQUS hosted and organised a very special Lecture for high school students: *"Talking to a Nobel Prize Winner"* at the CiQUS Seminar Room. Thus, Prof. Feringa (Nobel Laureate in Chemistry 2016) gave the talk "The art of building small" to 69 top high school students coming from 13 different centres. Afterwards, the students had the opportunity to discuss with Prof. Feringa during a very enjoyable coffee break. Prof. Feringa visited Santiago de Compostela on the occasion of his Honorary Doctorate by the University of Santiago de Compostela (initiative promoted by CiQUS).

In September 2019, CiQUS organised the round table "Women in Science" at the centre's Seminar room. This event included the participation of Prof. Nathalie Katsonis (ERC-CoG and ERC-StG grantee, MESA+ Institute for Nanotechnology – The Netherlands), Dr. María Giménez López (ERC-StG grantee, CiQUS PI), Dr. María Tomás (CiQUS Postdoctoral Associate) and Dr. Carolina Carrillo (MSCA-IF-ST Postdoctoral Researcher at CiQUS). They discussed on the difficulties for developing a scientific career, the gender bias and the opportunities to pursue a STEM position.

In November 2019, the CiQUS with the other Singular Research Centres of the USC (CiMUS and CiTIUS) and the IGFAE, organised the third edition of the **"Ciencia Singular" - Open Doors Day**, addressed to the general public (adults, families, teenagers, ...). This activity was co-funded by the Consellería de Cultura, Educación e Ordenación Universitaria through a signed agreement with the USC. Over 240 people (40% kids) visited the centre on November 16th, attended to the lectures and participated in the chemical games and experiments.

CiQUS also participated in external divulgation workshops, as the *Feira da Innovación Abanca-USC*, the Galicia Maker Fair, the local program *Una científica en cada cole* (A woman scientist in every school) and the Program “A Ponte entre o Ensino Medio e a USC”, a program from the USC for helping high school students to choose their future university studies (CiQUS PIs such as Prof. R. Riguera, Prof. C. González-Bello and Prof. D. Peña are regular collaborate as speakers within this program) and the Pint of Science in Santiago (organized by CiQUS PI Dr. P. del Pino). It is worth mentioning that the “Sociedade Xuvenil Galega de Química (SXGQ)”, a student’s association mainly formed by CiQUS PhD candidates, has an intense outreach activity through the whole year by visiting schools, scientific fairs and supporting several CiQUS outreach activities.

Furthermore, CiQUS researchers regularly visit regional public and private schools to give lectures. They also participate in other outreach activities organized by public libraries and civil organizations.

Finally, CiQUS PI Prof. Flor Rodríguez Prieto was invited to participate in the round table “Is there any gender balance in Science?”, A special outreach initiative organized in Santiago de Compostela to promote the visibility of women scientists among general public.

All CiQUS’ efforts significantly contribute to increasing the demand of Chemistry studies at USC and, last but not least, to build a more positive vision of chemistry and chemicals among the general public.



Some CiQUS pictures of outreach activities