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ICIQ: A 15-Year Journey

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The History of ICIQ

The idea of establishing a new research centre devoted to chemistry was proposed to me in June 2000 by Professor Andreu Mas-Colell, then the Minister for Universities and Research of the regional government of Catalonia. It was a really tempting proposal that I almost immediately accepted.

I still remember the very few requirements and conditions he translated to me in our initial conversation: the new institute would have the legal nature of a foundation, should be able to achieve a critical mass of approximately 300 people, should be guided by the ambition of becoming an international reference for chemical research, should be managed in a professional manner with well-defined decision-making procedures, and should be located in Tarragona, in a piece of land of approximately 14,000 sqm provided by Universitat Rovira i Virgili.

A lot of freedom was clearly involved in developing the project; this meant that countless decisions needed to be taken, from conceptual to architectural to organizational, that would shape the future institute. From a professional point of view, I remember the period of 2000–2003 as the most exciting in my life.

The architectural design and construction of the institute facilities received much attention at this stage of the project. The architect (Javier San José) was selected as the result of an open tender and, since modern chemical research buildings were not common in Spain, we managed to visit some research facilities (both industrial and academic) in Europe and in the US. This was a very inspiring and rewarding experience that I would recommend to anyone starting a similar project. We were very much influenced by many of the technical solutions and the lab design of the Hönggerberg facilities of ETH Zurich. It is not difficult to recognize their influence in our laboratories.

The construction and equipment of ICIQ was funded with equal contributions from the Generalitat de Catalunya and the

European Regional Development Fund (FEDER). By July 2003, the construction of the first ICIQ building had been completed and the Institute was officially inaugurated (Figure 1). During the next few months, hundreds of small technical problems were fixed and by March 2004 the first research groups arrived at ICIQ. It is important to mention that well in advance of the arrival of the research groups, the first Group Leaders to be hired had been selected with the valuable help of our Scientific Advisory Board, and that on several occasions during the construction period we met in Tarragona to discuss many issues on laboratory design and the scientific equipment of the Institute. In this manner, ICIQ became our collective creation.

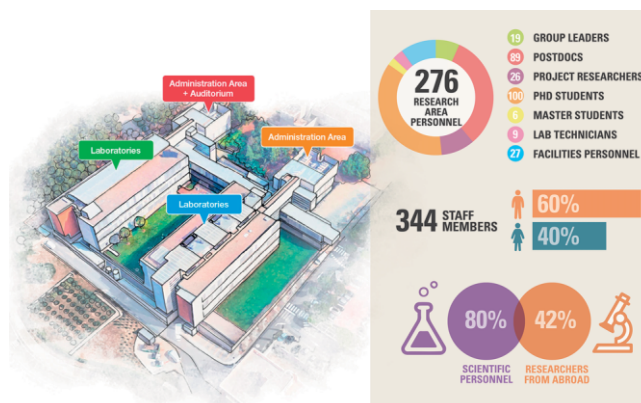


Figure 1. The ICIQ headquarters in Tarragona (Spain), with key figures on ICIQ staff.

At the outset of our activities, nine research groups were working at ICIQ (Ballester, Bo, Echavarren, van Leeuwen, Maseras, Mendoza, Pericàs, Vidal-Ferran, and Vilar), working on catalysis and supramolecular chemistry, both from experimental and theoretical perspectives. I would like to highlight that this combined theoretical and experimental approach has been, over the years, one of the most characteristic signatures of our approach to research and, probably, one of the keys that have led ICIQ to success. In retrospect, it is evident that the contributions from these nine groups were critical to gain momentum and to consolidate the position of ICIQ as a research centre, thus helping to attract and retain the young talent that ICIQ possesses today.

Soon the Institute started growing, and the selected preferential recruiting pathway was the ICIQ Tenure Track Programme, where emphasis was put on hiring young brilliant researchers. The first hires within the programme (Núria López and Javier Pérez Ramírez) represented the opening of two new perspectives

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in ICIQ research: theoretical and heterogeneous catalysis. They were followed by Emilio Palomares (photovoltaics), Arjan Kleij (supramolecular catalysis), Rubén Martín (metal catalysis), José Ramón Galán-Mascarós (functional materials), and Atsushi Urakawa (heterogeneous catalysis and operando spectroscopy). In 2010, due to both space and budget limitations, the Tenure Track Programme was discontinued. Undoubtedly, this was a very successful programme that has shaped the present and future of ICIQ. The six members of the programme got tenure and five of them were appointed as ICREA Research Professors serving at ICIQ. Collectively, the members of the programme have received four Starting Grants of the ERC and up to seven Proof of Concept ERC Grants.

In 2006, the Spanish Government launched its first initiative of excellence ever; it was the Consolider Programme, within the Ingenio 2010 strategy. In response to this call, most of the research groups at ICIQ, working in collaboration with groups from four Spanish universities (Huelva, Rovira i Virgili, Valladolid, and Zaragoza), got involved in the INTECAT project, aimed at developing an integrated approach to catalysis for the resolution of relevant problems and the subsequent transfer of the generated technologies. Our application was successful. Beyond the important economic injection (4.9 million € for the period 2006–2011) it represented for ICIQ the first experience of aligning our efforts for the achievement of collective goals. Later, the seed planted with INTECAT was key to the achievement, in 2014, of the accreditation of excellence Severo Ochoa (2014–2018) provided by the Spanish Ministry of Economy and Competitiveness (MINECO).

Although, as mentioned above, most of our growth has been based on the attraction and retention of young talent, the hiring of senior Group Leaders has also importantly contributed to the consolidation of ICIQ and to the creation of its scientific prestige. Antoni Llobet (artificial photosynthesis) joined ICIQ in 2006 from the Universitat Autònoma de Barcelona, and Steven P. Nolan (N-heterocyclic carbenes) arrived in 2006 from the University of New Orleans and was appointed as an ICREA Research Professor serving at ICIQ as a Group Leader. ICIQ offered an optimal environment for the development of the scientific career of these two researchers and their arrival at ICIQ was accompanied by a significant growth in their scientific impact.

By the end of 2006, almost all lab space in ICIQ's first building was booked and it became evident that the construction of an initially planned second building needed to be undertaken. The second building, with very modern labs and important technical improvements over those in the phase-one building, was designed by the same architect (Javier San José) and planned with the same philosophy: modular labs admitting easy reconfiguration, improved safety, and minimization of water and energy consumption. We could undertake this construction process with our own resources, a loan from MINECO, and the support of FEDER-EU funding. The new building, once completed, represented the addition of twelve research and two special labs (the headquarters of the Tenure Track Programme and of our Technology Transfer activities), specifically designed space for the theoretically oriented research groups of the Institute, office space, and a lecture theatre. Today, this second building has also reached full occupancy.

The building of institutional scientific prestige is not something that happens from one day to the next. Although the Institute planned its growth and activity with the ultimate goal of reaching scientific excellence, at least during the first years of our activities this endeavour was still in the terrain of hopes and expectations. The achievement of the INTECAT grant within the Consolider call was the first external indication that we were doing things properly. Later, the inclusion of ICIQ in leading positions of size-independent institutional rankings, such as Mapping of Scientific Excellence, was confirmation of these indications. In any case, external recognition does not represent a goal by itself; in our case, rather, it was motivation to continue striving in the same direction, in order to preserve what we had achieved.

Also, in research, playing in a major league provides intense exposure for your players. This could be viewed as a threat because wealthier teams can tempt your best players, but, in the long term, it brings beneficial effects on mobility, internationalization, and scientific renovation. Ramon Vilar, one of the founding group leaders, left ICIQ by the end of 2005 to take a position as Professor at Imperial College (London), allowing the arrival of Antoni Llobet. Javier Pérez-Ramírez, who had joined ICIQ as a junior Group Leader in 2005, left the Institute in 2009 to take a position as Professor of catalysis engineering at ETH Zürich, and Steven P. Nolan left ICIQ in the same year, shortly after receiving an ERC Advanced Grant, to take a position as Professor at the University of St. Andrews. As already mentioned, the last two moves made possible the arrival of new group leaders and new ideas to ICIQ. Paolo Melchiorre (organocatalysis, photocatalysis), Kilian Muñoz (activation and transformation of nitrogen compounds) and Vladimir V. Grushin (organometallic reaction mechanisms, nucleophilic perfluoroalkylation) reached ICIQ from Università di Bologna, Université de Strasbourg and DuPont, respectively, during 2009–2010. These are, to date, the last three senior Group Leaders incorporated into ICIQ staff. I can say with pride that all three have importantly contributed to the prestige and scientific excellence of the Institute, and ICIQ has witnessed years of very high creativity in their careers. Vlad Grushin decided to leave ICIQ in 2015. For reasons of age, Javier de Mendoza and Piet W. N. M. van Leeuwen retired from ICIQ in 2014 and 2015, respectively. Within this process of constant renewal, the ball is now in the playground of the members of our Starting Career Programme, which we will describe below. Chronological information of important events in the life of the Institute can be found in Figure 2.

Chemistry is a most powerful instrument to confront important societal challenges, such as renewable energy production and feedstock sustainability. Over the fourteen-year period since 2004, when ICIQ started operation, the research focus of the Institute has evolved in a natural manner from the original topics of catalysis and supramolecular chemistry to a new situation where research on renewable materials and energy plays an important role. Nowadays, ICIQ research activities focus on two main fields of research: catalysis of chemical processes and renewable energy and materials. Catalysis of chemical processes and its contribution to sustainable chemistry represent the Institute's most extensive research area. Its main purpose is to develop pro-

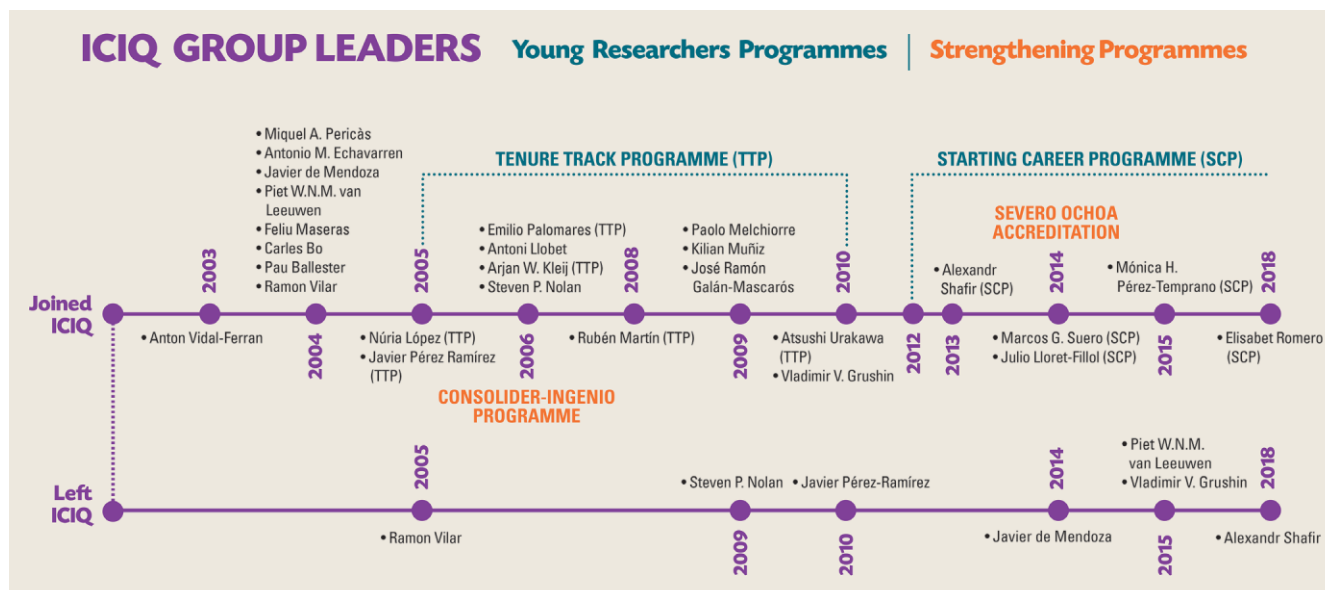


Figure 2. Relevant events in the history of ICIQ (2000–2018).

cesses and products that exploit resources more efficiently and minimize the generation of waste. It comprises research into all spheres of chemical catalysis: homogeneous, heterogeneous, and enantioselective catalysis, the development of new ligands and catalytic processes, and the design and theoretical simulation of catalytic reactors. On the other hand, the aim of our research on renewable energy and materials is that of contributing to the development of new energy solutions that represent viable alternatives to fossil resources. In this respect, several ICIQ groups are currently working on the generation of hydrogen from water through sustainable processes, the development of more efficient photovoltaic devices, and the conversion of CO₂ into liquid fuels and feedstocks for the chemical industry. In the long term, the combination of ICIQ's capabilities in these two fields will hopefully lead to substantial progress in addressing the following scientific/societal challenges: the generation of solar fuels from water by using sunlight as the sole source of energy, and the activation of small, carbon-based 'inert' molecules to improve the use of natural feedstocks and mitigate climate change. We have summarized in Figure 3 the current research map of ICIQ, from which the main goals and interactions between the current research groups can be appreciated.



Figure 3. Research at ICIQ: an overview.

Summarizing in a few lines the scientific achievements of ICIQ in its first fifteen years would be a rather impossible task if we had to go into particular details. In turn, the raw picture provided by the Web of Science (Figure 4) gives an accurate overview of the output of the research activities carried out by the Institute. A substantial part of this research has been funded by the European Research Council through Advanced Grants (Piet van Leeuwen and Antonio M. Echavarren), Consolidator Grants (Julio Lloret-Fillol and Paolo Melchiorre), Starting Grants (Emilio Palomares, Núria López, Paolo Melchiorre, Rubén Martín, José Ramón Galán-Mascarós), and Proof of Concept Grants [Núria López (1), Emilio Palomares (1), José Ramón Galán-Mascarós (3), Rubén Martín (2)]. The high number of Proof of Concept Grants (actually, one of the highest on a global scale) reveals one characteristic of the identity of ICIQ; that is, the close combination of interests of excellent research, and of knowledge and technology transfer. This characteristic has led to the development at ICIQ of open innovation initiatives (ICIQ–industrial joint units) and Technology Development Units currently evolving into the first ICIQ-incubated spin-offs.

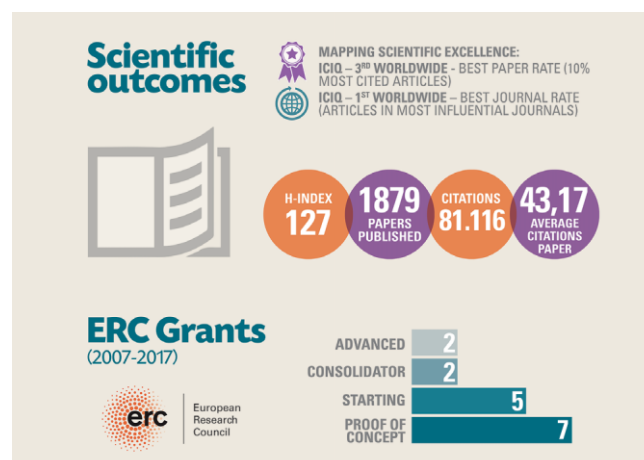


Figure 4. ICIQ output: facts and figures.

Approaching the end of this overview, I would like to refer to the scientific future of ICIQ. This now relies on our Starting Career Programme. This initiative, launched in 2012, is our current approach to hosting and guiding young, excellent researchers in the initial steps of their independent careers. The programme was designed in the context of the blocking of new permanent positions in the Spanish science system and involved five-year non-tenurable contracts. In order to adapt to international standards and to the time length of research grants in Spain, the duration of these contracts has been recently increased to four-plus-three years with intermediate evaluation. Within this programme ICIQ has hosted Alexandr Shafir (catalytic conversion of ethylene into α -olefins, 2013–2018), now a Científico Titular at CSIC, Julio Lloret-Fillol (production of solar fuels and new light-driven catalytic transformations of organic substrates, 2014–), now an ICREA Research Professor and ERC Consolidator Grant recipient at ICIQ, Marcos García-Suero (catalytic C–H functionalization strategies, 2014–), Mónica H. Pérez Temprano (new catalytic organometallic processes through mechanistic studies, 2015–), and Elisabet Romero (bio-inspired systems for the conversion of solar energy to fuels, 2018–). Hopefully, this young generation will shape the future of ICIQ in the framework of the EU science system.

I would like to finish this brief account by referring to the core values of ICIQ. In a few words, we try to perform cutting-edge research that is able to improve quality of life in a sustainable manner, and we try to do that according to the principles of responsi-

ble research and innovation (social engagement, open-access publications, ethics in research, gender balance, and outreach). Social engagement stands for our compromise with Society for the proper use of public resources devoted to the Institute activities. Besides the generation of useful scientific knowledge, the most precious product of ICIQ is talent. We receive graduate students and young PhD students from Society and we return these students to Society transformed into future scientific and industrial leaders. The 160 graduate students that have completed a PhD at ICIQ, and the approximately 250 post-doctoral researchers that have worked at the Institute since 2004, are the practical result of this activity. It has been our privilege having them with us. The Institute is a complex machine; research groups, management, research support area, and administration are all fundamental for its success. I would like to take this opportunity to thank all the staff at ICIQ for their contributions to the global success of the Institute.

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