

COLLABORATION

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Photonics Network**

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Community News Spring 2021

Bench to Bedside Translation

BARCELONA MEDICAL PHOTONICS NETWORK

An ICFO



**Light for
Health** Initiative



LETTER FROM THE DIRECTOR

Brook Hardwick
Contributing Editor



Here Comes the Sun

Spring is a time for hope, for a transition from the short, dark days of winter to days when the sun shines through, new growth emerges and everything comes alive.

In times of pandemic, there is no end to the parallels that we could draw between the season and our hope that we are emerging into a brighter, healthier, “sunnier” moment. With springtime in the air, there is also a lot of “sunshine”, new growth and reasons for optimism in this edition of ICFONIANS.

In February it came as a relief to celebrate an annual tradition- the *ICFONIANS for Women in Science Month*. Undeterred by restricted travel due to COVID containment measures, guest speakers from around the world participated in the event made possible by Zoom. Prof Halina Rubinsztein-Dunlop (Australia), Dr Allison Romanyshyn (US), Dr Reiko Yamada (ICFO), Dr Ino Agrafioti (Belgium) and Dr Jess Wade (UK) were all able to dial in, literally from the four corners of the planet, to share personal and institutional initiatives that empower and increase the visibility of women in science. Having focused during the first years of the *ICFONIANS for Women in Science Month* on drawing attention to the current gender disparities and challenges for women, this refreshing and action-oriented agenda was an upbeat call for us all to take confident, concrete steps towards a future where more women are empowered to go further to advance the scientific enterprise.

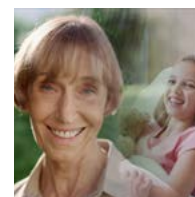
At the end of February, overlapping and aligned with the goals of this event, ICFO celebrated the first CARLA camp, part of a Europe-wide initiative coordinated by

ICFO to boost the number of students and early-stage researchers pursuing careers in photonics. The camps focus on increasing the employability of university students as well as early-stage researchers from photonics and non-photonics focused areas, encouraging innovation and entrepreneurship and empowering diversity in Photonics. There is no more powerful tool to shape the future than to invest in the potential of young talent. This camp, organized by ICFO, is the first of 11 such career camps that will take place all over Europe through December 2022.

ICFONIANS are well aware that Photonics is considered a Key Enabling Technology (KET) found at the core of a wide range of products and technologies. The need for inter-disciplinary collaboration, cross pollination if you are thinking in terms of Spring, is central to the advancement of much of our work. Nowhere was this more evident than in the recent launch of the Barcelona Medical Photonics Network (pg 7) that promotes the research and development activities carried out in and around Barcelona through long-standing collaborations between ICFO and its numerous clinical partners. The collaborative seeds planted over the past decade through ICFO's Light for Health program have blossomed into relationships that are allowing ICFO researchers and clinicians to work together to directly improve patient outcomes.

Please read on for more good news from our ICFO community.

COVER



As the saying goes, “it takes a village to raise a child”. It is equally true that it takes close interdisciplinary R+D collaborations to bring children into the world, detect, understand, monitor and treat the health issues they may develop

throughout their journey to old age. On February 18th, we celebrated the consolidation of the Barcelona Medical Photonics Network that promotes the research and development activities carried out in and around Barcelona through long-standing collaborations between ICFO and its numerous clinical partners. Read more on pg 7.

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Science Quiz

Answers from p.12 1:A 2:C 3:C 4:B

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HAPPENINGS



**BENCH TO BEDSIDE
TRANSLATION**

The Barcelona Medical
Photonics Network

p. 7

ICFO NEWCOMERS

Welcome to ICFO

Many of us joined ICFO or took a new position at the institute between January and March. **WELCOME TO ICFO!**



Olivier Messenger
KTT



Carlota Corbella
KTT



Gabriel Fernandez
PhD Student



Eduardo Arqué
PhD Student



José Javier Ruiz
PhD Student



Luke Mortimer
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Kostas Mouloudakis
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Gian Marcello Andolina
Postdoc



Muhammad Atif Yakub
Postdoc



Daniel Hümmer
Postdoc



Daniel Senciales
Research Engineer



Goretti Torres
Student



Adrian Pinilla
Student



Carolina Fajardo
Student



Saad Abdullah
Student



Jan Krpenský
Student



Martin Hauden
Student



Alberto De Toni
Student



Jessica Barrantes
Student



Maria Prat Colomer
Student



Jennifer Anais Sánchez
Student



Nuria Moral Blázquez
Student

Not Pictured

Jaume Villasante
Student

Helena Kirchner
Student

Anna Migó
Student

Diana Pineda
Student

HAPPENINGS

ICFO NEWS

ICFO Group Leaders in Top Worldwide Ranking for "Career-long" Citation Impact



Researchers from Stanford University recently published an updated version of their 2017 study about scientific citations, ranking the "career-long" citation impact of about 160,000 scientists in all disciplines, sorted by field. **ICREA Professors at ICFO Javier García de Abajo, Maciej Lewenstein, Antonio Acín and Niek van Hulst, as well as ICFO's director, Prof Lluís Torner are ranked among the top 0.5% in the world, in their subfield.** This study uses data from Scopus with data freeze as of May 6, 2020, assessing scientists' impact up until the end of 2019. It measures career-long impact and is based on a sophisticated model that uses several assumptions and indicators. Data is provided with and without so-called self-citations, which in this analysis is taken to the extreme as the latter include even citations by any author of a given paper (i.e., not necessarily by the considered author).

New Tenured Scientist



Dr Robert Sewell, Head of Academic Affairs, has recently been awarded tenure by the Board of Trustees of the institute. Rob joined ICFO as a Marie Curie Research Postdoctoral Fellow in 2009 in the group of Prof Morgan Mitchell, leading a research laboratory in experimental quantum optics, developing new techniques for quantum-enhanced optical magnetometry with laser cooled atoms, and demonstrating how spin squeezing and entanglement generated by quantum non-demolition measurements can help improve precision measurements of magnetic fields. In 2014 he was appointed Staff Scientist and Coordinator of Academic Programs at ICFO, responsible for graduate education and training programs. In addition, he is Co-Director of the Master of Multidisciplinary Research in Experimental Sciences offered by the Universitat Pompeu Fabra (UPF) in collaboration with The Barcelona Institute of Science and Technology (BIST) and in 2020, he was appointed SPIE@ICFO Chair for Diversity in Photonic Sciences.

Quantum Highlights of the Year in Nature Communications



Nature Communications has published a focused collection of articles to highlight some of the most amazing advances that quantum technologies have achieved in the past year. The study carried out by an international team of researchers led by **ICREA Prof at ICFO Morgan Mitchell** entitled "*Measurement-induced, spatially-extended entanglement in a hot, strongly-interacting atomic system*", also mentioning the Quantum Flagship projects QRANGE and macQsimal, was included in this highlighted collection. While the world is in the midst of a second quantum revolution with quantum physics demonstrating its potential to become an essential ingredient of our future disruptive technologies, we continue to carry out applied and fundamental research, going beyond the frontiers of knowledge to discovered unfathomable phenomena.

Laserlab-Europe AISBL Elections



LASERLAB-EUROPE, the integrated initiative of European laser research infrastructures, is a EU H2020 research project that aims to strengthen Europe's leading position and competitiveness in this area. In order to give this long-term project continuity, Laserlab-Europe AISBL was formed as an international not-for-profit association. **ICREA Prof at ICFO Dr Jens Biegert has recently been elected Chair of the AISBL General Assembly**, AISBL's decision-making body consisting of 45 institutions, including ICFO, across 22 countries as voting members. Prof Biegert has an established record of active engagement with Laserlab-Europe, currently also serving as Chair of the Networking Board of Laserlab-Europe and in its Management Board.



OSA David Richardson Medal

The Optical Society (OSA) annually awards the prestigious David Richardson Medal to an individual in recognition of their significant contributions to optical engineering, primarily in the commercial and industrial sector. The 2021 Medal has been awarded to **ICREA Prof at ICFO, Dr Majid Ebrahim-Zadeh, leader of the Optical Parametric Oscillators research group**, "*for contributions to the advancement of nonlinear optical technology and commercial development of cutting-edge optical parametric oscillators.*" Prof Ebrahim-Zadeh has been at the forefront of research in nonlinear optics and frequency conversion technology for over 25 years. His pioneering contributions to the field have led to the realization of new generations of uniquely versatile laser sources spanning the ultraviolet to the mid-infrared, and in all time-scales from continuous-wave to few-cycle femtosecond domain. He has a long-standing track record of successful



technology transfer and industrial innovation, having created Radiantis, the first spin-off company from ICFO, in 2005. Today Radiantis is recognized as a leading manufacturer of cutting-edge OPO technology in the world and is fully integrated into the laser and photonics market.

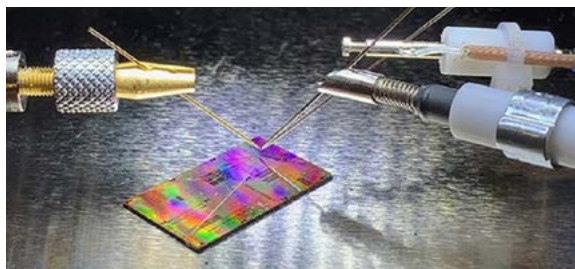
EPS Emmy Noether Distinction

The European Physical Society (EPS) recognizes outstanding contributions of individual physicists in their research, education and service to EPS through special distinctions. The Emmy Noether Distinction for Women in Physics was established to bring noteworthy women physicists to the wider attention of the scientific community, policy makers and the general public and to identify role models that will help to attract women to a career in physics. This year, **ICREA Prof at ICFO Dr María García-Parajo, leader of the Single Molecule Biophotonics group**, has been selected as the laureate of this prestigious award "*for her outstanding contributions to nanobiophysics and to numerous programs to support women in physics*". Prof García-Parajo remarked upon receiving the award that "*this award means a lot to me as a recognition for scientific achievements. Even more importantly however, it reinforces my firm commitment to continue supporting younger women in Science and to show by example that even though it is hard, a career in science is possible.*"



LATEST ADVANCES

A Performance Leap for Graphene Modulators in Next Generation Datacom and Telecom

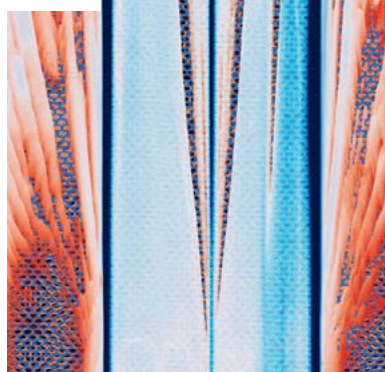


Electro-absorption (EA) modulators that modulate the amplitude of the light passing through the optical waveguide are key components in new next generation telecom devices. Graphene-based modulators have already shown broadband optical bandwidth and temperature stability, but in occasions, have been incapable of showing both high-speed and high modulation efficiencies simultaneously. In a study published in *Nature Communications*, ICFO researchers led by **ICREA Prof Dr Frank Koppens**, in collaboration with Universita di Pisa, CNIT, Ghent University-IMEC, and NIMS have reported on **a novel EA modulator capable of showing a 3-fold increase in static and dynamic modulation efficiency while maintaining the high-speed, a value that surpasses those for previously reported graphene EA modulators.**

The graphene-based electro-absorption modulator was created by combining high-quality graphene, achieved by integrating it with the 2d-material dielectric hexagonal boron nitride (hBN), and a high-k dielectric. Researchers then added the high-k dielectric material HfO₂ sandwiched in between two layers of boron nitride, permitting the operation with much smaller voltages, and, at the same time, achieving symmetric and hysteresis-free due to the high quality of the graphene. By doing this, the dielectric combination was able to enhance the EA modulator capacitance without compromising the robustness of the device against high voltages, preserving the high mobility of charge carries (increasing the modulation efficiency) while maintaining low levels of doping.

Universal Sequence of Chern Insulators in Superconducting Magic Angle Graphene

In a study published in *Nature Physics*, a team of scientists led by **ICFO Prof Dr Dmitri Efetov**, together with colleagues from Princeton and the National Institute for Material Sciences, report a full sequence of symmetry broken Chern insulators within the flatbands of magic angle graphene.



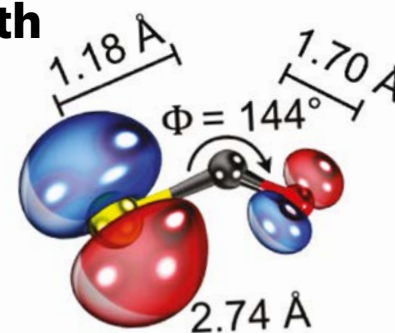
The newly discovered Chern insulators in magic angle graphene which only consists of non-magnetic carbon atoms, originate from strong correlation induced symmetry breaking. Researchers used the magneto-transport technique to measure longitudinal and hall resistance. They managed to observe Chern insulators with a magic sequence of quantized Hall conductance $C = \pm 1, \pm 2, \pm 3, \pm 4$ which nucleate from integer fillings of the moiré unit cell $= \pm 3, \pm 2, \pm 1, 0$ correspondingly. The magic sequence and correspondence of Chern numbers and filling factors suggest that these states are driven directly by electronic

interactions which specifically break time-reversal symmetry in the system.

Furthermore, they studied quantum magneto-oscillations in the yet unexplored higher energy dispersive bands of magic angle bilayer graphene. In magnetic field, the energy spectrum shows a rich sequence of level crossings which directly come from the unique Rashba-like dispersion of the bands. Further analysis of the Landau level crossings allowed them to provide constraints on the parameters w_0 and w_1 of the Bistritzer-MacDonald MATBG Hamiltonian.

Determining the Structure of a Molecule With Laser-Induced Electron Diffraction

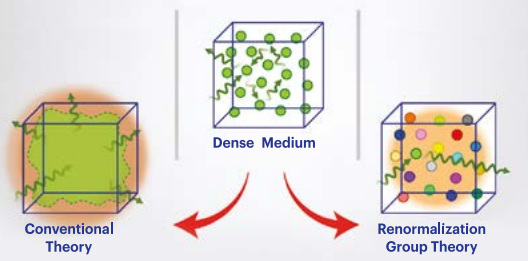
Laser induced electron diffraction (LIED) allows for the imaging of molecules, however the use of a strong laser field to generate the electron diffraction presents challenges in retrieving the exact structure, since the structural resolution depended on exact knowledge of the laser field itself. In a study recently published in *Nature Communication*, **ICFO researchers led by ICREA Prof Dr Jens Biegert**, in collaboration with researchers from Kansas State University, Max-Planck-Institut für Kernphysik, Physikalisch-Technische Bundesanstalt, and Friedrich-Schiller-Universität Jena, report on an alternative and novel approach that retrieves accurate and precise information about the atomic structure without exact knowledge over the laser field. They successfully applied the method to imaging gas-phased molecule Carbonyl



Sulfide (OCS), in particular on the bond lengths between the constituent atoms, showing a significantly bent and asymmetrically stretched configuration of the ionized OCS⁺ structure.

The scientists took a gas mixture of 1% OCS in helium and expanded it supersonically to create a molecular beam of the gas with a temperature below 90K. They then took a 3.2μm laser and exposed the molecule to the strong laser field. The interaction between the laser and the molecule produced an accelerated electron, which was released from the molecule, accelerated into the laser field and returned back to the target ion by the electric field of the laser; the re-collision of the electron with the ion structure generated a molecular imprint of the structure and, by extracting this information from the electron interference pattern and the scattering angle analysis, they were capable of determining the proper structure of the molecule.

Why Are Optical Refractive Indices so Small?



In a recent study published in *Physical Review X* and highlighted by the editors, **ICFO researchers Francesco Andreoli and ICREA Prof Dr Darrick Chang**, in collaboration with researchers from Princeton University, University of Chicago and Institut d'Optique, have investigated and explained why the refractive index of a dilute atomic gas can only reach a maximum value of 1.7, regardless of how high the density of atoms becomes.

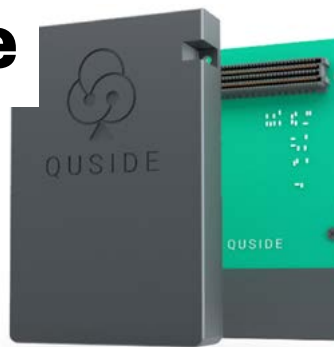
The researchers made use of a theory, called strong-disorder renormalization group (RG), which enables them to capture granularity and multiple scattering effects in a simple way. This theory shows that the

optical response of any given atom is disproportionately affected by its single nearest neighbor because of near-field interactions. The physical effect of the near-field interactions is to produce an inhomogeneous broadening of atomic resonance frequencies, where the amount of broadening grows with density. Thus, no matter how high the physical density of atoms is, incoming light of any frequency will only see about 1 near-resonant atom per cubic wavelength to efficiently scatter off, which limits the refractive index to its maximum value of 1.7.

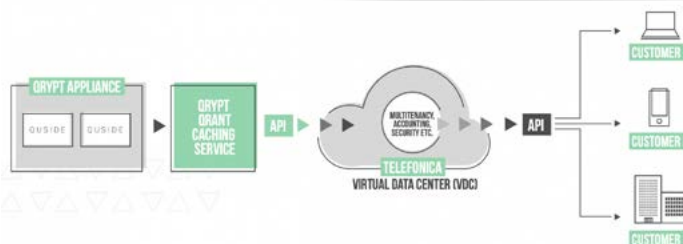
HAPPENINGS

BUSINESS NEWS

Telefónica Tech, Quside and Qrypt Collaborate to Validate New Quantum Technology



Telefónica Tech Ventures has collaborated with Quside, an ICFO spin-off and industry-leading manufacturer of high-performance quantum random number generators, and New York-based Qrypt, a producer of cryptographic quantum security solutions enabled by its Quantum Entropy-as-a-Service (EaaS) solution, to successfully complete the integration of a new quantum technology into its cloud service hosted in its Virtual Data Centers (VDC).



The availability of large quantities of high-quality random numbers has become an essential requirement in many fields. In addition, "go-to-cloud" and "cloud-first" strategies are now a necessity in the ICT industry. It is forecast that a high percentage of total spending on enterprise applications will be spent on cloud services by 2023, with a significant portion of this to be spent on tasks that require random numbers, especially in the financial sectoral sector.

This collaboration allows Telefónica Tech to enhance its cloud services by providing its customers with easy-to-use, high quality and high-performance quantum random numbers so they can integrate them into their business processes.

Telefónica Tech has validated the use of quantum random number generators in a new Entropy-as-a-Service (EaaS) architecture, integrated into its VDC cloud offering. Several use cases have been demonstrated using this EaaS integration, including seeding

for cryptographic devices (HSM), Monte Carlo simulations for scientific, engineering, and financial applications, gaming, as well as for a new proof-of-transit protocol that improves the security of data transiting software-defined networks (SDN).

"Offering this key quantum-generated resource is a significant advantage for both our internal and external customers", remarks **Hugo de los Santos**, Director of Products and Services at Telefónica Cyber & Cloud Tech. "It is especially important for our enterprise customers with demands for high quality and high-performance random numbers, who will benefit from this unique feature".

"Randomness is an essential resource for a wide range of ICT systems, including cybersecurity", adds **Dr Carlos Abellán**, Quside CEO and ICFO alumnus. "We are thrilled to be part of Telefónica Tech's efforts to deploy stronger security features to their global customers using emerging quantum technologies."

Qurv's Award Winning Wide Spectrum Image Sensor



ICFO Spin-off recognized at major industry event for innovations that epitomize electronics industry innovation

Qurv, an ICFO spin-off company launched in 2020 that develops wide-spectrum image sensor technologies and integrated solutions to enable enhanced computer vision applications, took part in the Technology Showcase at the MEM & Imaging Sensors digital forum at the Technology Unites Global Summit and were pronounced winners for best imaging technology. Technology Showcase winners were selected from five finalists in each category in a vote by a committee of industry experts. Sharing the podium as the leading MEMS technology was Infineon Technologies who produce environmental sensors.

"Image and MEMS sensors advances are delivering tremendous societal and economic benefits, making our lives safer and healthier and the air cleaner," said **Laith Altimime**, president of SEMI Europe, a global industry association representing the electronics manufacturing and design supply chain. "The Qurv and Infineon Technologies innovations epitomize electronics industry innovation."

Dr Stijn Goossens, Qurv's CTO represented the company at the event. He comments, "This award provides invaluable recognition of all the effort that the team behind Qurv has put into developing an advanced imaging technology that aims to enhance machine perception and augment human capabilities. At scale. We will continue working toward that vision."

ICFO in Top 10 in Patent Creation



ICFO among universities and research centers cited for their significant contribution to innovation

In early March, the European Patents Organization (EPO) published the 2020 patent index detailing the number of new patents registered in Spain last year. "Despite the pandemic, Spanish inventors remained very active in 2020, and universities and research institutions once again made a significant contribution to innovation," said the president of the EPO, António Campinos. Emphasizing the importance of this data, Campinos also pointed out that "science, research and innovation, backed by a solid intellectual property system, is more important than ever to make our world safer, smarter and more sustainable, and to promote the economic recovery". **ICFO has been an important contributor in this regard, ranking in the top ten of companies and research institutes in patent**

applications for the third consecutive year. Among the companies and institutions in the top ten, the Consejo Superior de Investigaciones Científicas (CSIC) came out in first place with 72 applications, followed by Amadeus (60), Esteve Pharmaceuticals, Tecnalia Research & Innovation Foundation and Telefónica (17 each), Universitat Politècnica de Catalunya, (15), PharmaMar (14), Repsol (14), and **ICFO**, Autotech Engineering and SEAT (11 each).

ICFO's Knowledge and Technology Transfer (KTT) team plays a key role in connecting industry with exciting developments in ICFO laboratories. KTT director **Dr Silvia Carrasco** comments that "A key aspect in our efforts to bring ICFO's innovations all the way from the labs towards products that can improve people's lives is to build solid and strategic patent portfolios around the exciting technologies developed by ICFOians".

BENCH TO BEDSIDE TRANSLATION

The Barcelona Medical Photonics Network



8 prominent health institutions in the Barcelona area, their research institutes and ICFO join forces through the creation of a network to bring cutting-edge photonic technologies to hospitals

As the saying goes, "it takes a village to raise a child". It is equally true that it takes close interdisciplinary R+D collaborations to bring children into the world, detect, understand, monitor and treat the health issues they may develop throughout their journey to old age. February 18th marked the consolidation of the Barcelona Medical Photonics Network that promotes the research and development activities carried out in and around Barcelona through long-standing collaborations between ICFO and its numerous clinical partners.

Because of its exceptional versatility, precision, and non-invasive nature, photonics is playing an increasing role in medical techniques and practices, to the extent that today it is considered a key enabling technology in developing healthcare in Europe. Researchers at ICFO have extensive expertise in the development of photonic-based technologies for clinical use, in collaboration with doctors around the world, and especially in the Barcelona area.

Successful bench-to-bedside translation of new technologies requires the collaborative efforts of experts in different fields, ensuring that research around medical technologies are continuously aligned with the needs of citizens and society at large. **After over a decade of close collaboration with hospitals and health care specialists in the Barcelona area, the formalization of the Barcelona Medical Photonics network enables the solidification and expansion of the reach, scope and impact of these critical relationships.** This network is part of the Light for Health program at ICFO, an initiative that was launched and took root thanks to the impetus of the Cellex Foundation, and continued to grow through the continuous support from the "la Caixa" Foundation, Barcelona City Council, as well as state and European funds.

The main established joint endeavors to date have spanned initiatives in disciplines such as neurology and neurosurgery, neonatal care, ophthalmology, oncology, intensive care monitoring, dermatology, rapid clinical analysis, rehabilitation, sports medicine, wellbeing, sleep disorders and anesthesiology, among others.

Impact on Society

The Network aims to have an impact on society at many levels:

1. Sharing and contrasting of best practices for technology use, adoption and dissemination of results amongst care centers.
2. A formal structure that will allow for increased focus on a wide-range of patient scenarios that ultimately improves patient outcomes.
3. Flexibility to participate as a block in international initiatives and projects, primarily from the European Union, to expand the common research goals of the network partners.
4. Preparedness for engagement in emergencies, such as COVID, to rapidly and effectively test new technologies to meet emerging requirement for critical patient care.
5. An expanded range of data points from around Catalonia (age, geography, pathologies) for testing technologies providing reliable and insightful analysis.

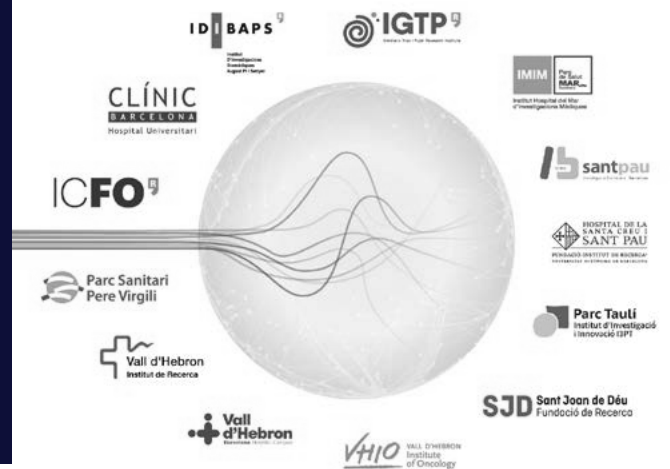
Video Introduction



+ Info

barcelonamedicalphotonics.icfo.eu

Network Partners



ICFO Medical Technologies

Diffuse optics for non-invasive deep tissue monitoring & imaging

Medical Optics Group @ICFO

What does it measure?

Advanced Imaging Ex-and In-Vivo

Super-resolution Light Microscopy and Nanoscopy Lab @ICFO

- Raman molecular profiling
- Ophthalmic microscopy
- Fast dynamics imaging
- 3D imaging of living samples
- Cell and sub-cell level visualisation

Other Technologies

Other health-related technological capabilities for **DIAGNOSTICS, THERAPY, MONITORING and PROGNOSIS:**

- Point-of-care devices for early and ultraprecise detection from a drop-like sample
- Nanomaterials for personalized therapy
- Wearable devices monitoring vital parameters

"It is incredibly rewarding to watch our science and technology, often based on very frontier physics, move into hospitals where it can help doctors better care for their patients. This journey requires a lot of perseverance and sustained support. Fortunately, for the past decade we have had this thanks to visionaries from the Cellex and "la Caixa" Foundations, Barcelona City Council and the DGR of the Government of Catalonia. We thank everyone for their support and the doctors for their participation."

Lluís Torner, Director of ICFO

"Our goal is to see technologies enabled by advanced photonics in clinical practice. We will do that by working together with clinicians and biomedical researchers of this network, with industry and ultimately with governments. Barcelona area is a world-class place to achieve this goal with its diverse array of hospitals, research centers and companies as well as the support infrastructure."

ICREA Prof Dr Turgut Durduran, leader of the Medical Optics research group at ICFO

"The 'Light for Health' program at ICFO has been working for years to build the trust, understanding and types of productive relationships with doctors and clinical and biomedical researchers that we have consolidated with the Barcelona Medical Photonics Network. Their knowledge of the patients' needs, and their motivation to work with interdisciplinary partners to meet those needs, are the central pieces of this puzzle, without which new technologies would have no hope of saving lives."

Ariadna Martinez, KTT, coordinator of the Light for Health Program at ICFO

COLLABORATION

RESEARCH

New ICFO Coordinated Projects

ICFO takes the lead in diverse high-profile research initiatives

QUANTUM CRYPTOGRAPHY IN CRITICAL COMMUNICATIONS

First steps towards the implementation of the European Quantum Communication Infrastructure (EuroQCI)

The project *Quantum Cryptography in Critical Communications* launched by the Government of Catalonia, ICFO and Cellnex, will develop and validate a quantum distribution system of cryptographic keys that will be implemented through a pilot test, done via a point-to-point link between ICFO's facilities in Castelldefels, and the Center of Telecommunications and Information Technologies (CTTI), located in L'Hospitalet del Llobregat, Barcelona.

The project is part of the Research and Innovation Program in Advanced Digital Technologies promoted by the Government of Catalonia through the Department of Digital Policies and Public Administration, and is coordinated by ICREA Prof at ICFO Dr Valerio Pruneri, together with the collaboration of the company Cellnex, manager of the Open Network of Catalonia, and the Foundation i2CAT, provider of part of the software needed to carry out the test.

The main objective of the pilot is to carry out a field test for the implementation of a secure communication system, point-to-point, that includes quantum communication technology, which will use the secure communication method called *Quantum Key Distribution (QKD)*. This test implies the materialization of concepts in real implementations for the industry and the general public, while seeking to validate the true



The pilot *Quantum Cryptography in Critical Communications* will be deployed in a 30-kilometer fiber-optic link between ICFO and CTTI.

advantages of this technology with respect to current systems thanks to its easy integrability and cost but, above all, its significant market potential.

This project is part of several initiatives to be implemented for the development of the future pan-European quantum communications infrastructure (EuroQCI). EuroQCI is an initiative of the European Commission that will provide Europe with a quantum communications network and which will be deployed in the next 10 years.

This future infrastructure, which is certified point-to-point, will allow the transmission and

storage of data and information in a completely secure manner, through connections between the different key infrastructures within the European Union, achieved through terrestrial and satellite links.

EuroQCI will seek to demonstrate different use cases in which this new ICFO coordinated project is a first step, paving the way for Catalonia to have a relevant role in the future in areas such as cybersecurity for data centers, communication between satellites and Earth, as well as protection of electrical distribution networks and governmental communications.

TINY BRAINS

H2020 project that aims to develop an optical neuroimaging device for assessing brain damage in infants born with severe congenital heart-defects.

The survival rate of babies born with congenital heart-defects (CHD), has increased greatly over the past decade, with more than 85% reaching adulthood. However, about 30% of these children will have mild to severe neurodevelopmental disabilities which studies have shown arise because of ongoing brain injury due to periods of insufficient oxygen delivery to the brain from the fetus life to early childhood. To change the natural course of the disease and to prevent brain injury in CHD infants, an in-depth analysis of the mechanisms of injury combined with innovative technology that seeks to develop new monitoring tools is urgently needed.

The European project *Tiny Brains*, coordinated by ICREA Prof at ICFO Dr Turgut Durduran, aims to develop an advanced photonics-based neuro-imaging device for infants, using a multi-modal approach to understand the mechanisms underlying brain damage in CHD



patients. It intends to provide a research platform to improve the understanding of the cellular origin of the brain injury by enabling the assessment of the link between energy demand and oxygen supply.

It will combine advanced biophotonics technologies and electroencephalography into a disruptive research tool to measure cerebral hemodynamics, oxygen metabolism and electrophysiology simultaneously. In vivo imaging in three-dimensions, i.e. tomography will greatly increase the brain specificity and penetration as well as, for the first time, providing spatial resolution to this class of measurements.

A consortium of six partners will work together for the next 4 years and includes the following entities: ICFO (Coordinator, Spain) and the University de Picardie Jules Verne (France) as technology developers in academia; the Sant Joan de Déu Hospital (Spain) for pre-clinical and clinical testing; and HemoPhotonics (Spain), BioPixS (Ireland), and Seenel (France) as industrial partners.

This project has received funding from the European Union's Horizon 2020 research and innovation.



European Commission

Horizon 2020
European Union funding
for Research & Innovation

COMMUNITY

Diversity and Inclusion at ICFO

The annual ICFOnians for Women in Science month celebration continues as an important illustration of ICFO's commitment to supporting and increasing diversity in all its forms.



ICFO's institution-wide tradition of celebrating the International Day of Women and Girls in Science began in 2016, the same year that the UN declared the International Day. In 2018, we extended the celebration all the way to March 8th, International Women's Day, in order to dedicate an entire month to related discussions and activities.



While there is a concentration of events that take place during this month, ICFO's commitment to supporting and increasing diversity in all its forms is a year-round activity. Diversity, along with respect for others and scientific rigor, is one of ICFO's core values which is why it is important that every day we work to create an inclusive environment where all staff and students can thrive and fully participate. By providing access to opportunities and increasing the visibility of positive female role-models in science, we aim to encourage even more girls in the next generation to pursue careers in STEM.

All ICFOnians regardless of their gender, research focus or management responsibilities, set aside this month to focus on the role of women in scientific discoveries as well as the ways that we can all support women to reach their full potential in their careers.

While there is much work to be done, ICFO has taken many steps to make our institute a diverse and inclusive place to work:



MARÍA YZUEL FELLOWSHIP AWARDS

ICFO aims to strongly support and encourage women's participation in science through the María Yzuel Fellowship Awards, which offer outstanding students the possibility to explore science by accomplishing a final degree project / masters' thesis, or research project.

OUTREACH ACTIVITIES

Outreach is one of the priority missions at ICFO. Special attention is paid to include the gender dimension in the design and implementation of Outreach activities as well as in targeting participation. ICFO is always looking to transmit an unbiased image, to give visibility to the achievements of female scientists and to promote female role models.



WOMEN FOR AFRICA PROGRAM

Since 2016, ICFO has participated in the Women for Africa Foundation's program Science by Women (Ellas Investigan) that aims to enable African women researchers and scientists to tackle the great challenges faced in their home countries. Each year since the program began, ICFO has hosted senior scientists who have joined our institute to further their research and to share in our scientific community.

SPIE@ICFO CHAIR FOR DIVERSITY IN PHOTONIC SCIENCE

In June 2020 SPIE, the International Society for Optics and Photonics, and ICFO formally announced the SPIE@ICFO Chair for Diversity in the Photonic Sciences in order to promote diversity and to support new talent in photonics to enhance innovation, creativity and excellence in research. The chair will leverage the center's activities to further enhance its promotion of diversity, starting with its multiple programs supporting the education and careers of young women from diverse backgrounds with an interest in photonics.



2021 AGENDA

- February 11, Inaugural event with Invited Speaker**
Prof LLUIS TORNER
Director's Introduction
Prof HALINA RUBINSZTEIN-DUNLOP
Equity, diversity and inclusion in science and for science – How are we doing?
- February 17, Invited Speaker**
Dr ALLISON ROMANYSHYN
Equity, diversity and inclusion – what SPIE can do
- February 22, Invited Speaker**
Dr REIKO YAMADA
Women and creative process: What science can learn from arts?
- February 25, Invited Speaker**
Dr INO AGRAFIOTI
ERC policies to equalize the opportunities of men and women in getting ERC funds
- March 1, Invited Speaker and Workshop**
Dr JESS WADE
Why we need to keep speaking about equity in science – Case study Wikipedia

OUTREACH EVENTS

- February 11**
Photonics in 5 Minutes!
- February 11**
#100tifiques
- February 23, 24, 25**
CARLA camp

INSTITUTIONAL INITIATIVES

- Lactation Room
- Career development and networking
- Avoiding unconscious bias in recruiting
- Health and Safety protocols for expecting and lactating women

DIVERSITY AND INCLUSION COMMITTEE ACTIONS

- Inclusive Language Guidelines 
- Harassment and Bullying Protocol 

POSTERS

Check out all Posters that were displayed in the NEST HALL throughout the month 

COLLABORATION

OUTREACH

Quantum Technologies in 5 Minutes

On February 11th in the framework of ICFOnians for Women in Science month, a special edition of *Photonics in 5 minutes* was held to celebrate the International Day of Women and Girls in Science. For the occasion, the panel was chosen to give visibility to the role of women in STEM. The virtual event, that was directed to secondary school students from 14-18 years old, drew the interest of 25 different schools across Spain, resulting in over 1100 registered participants. The session took place in YouTube Live where, following an enthusiastic introduction by Dr Federica Beduini, three ICFOnians each gave an inspiring 5-minutes flash talk on how photonics is important for their research and society in general. The speakers had very different takes on the topic: Prof Leticia Tarruell focused on cooling atoms and creating



quantum matter, Giulia Lo Gerfo on green energy and Dr Martina Giovannella on the biomedical applications of photonics. After the presentations, the students had the opportunity to ask their questions about the science as well as the life of a researcher, engaging the speakers in a fun and enriching roundtable.

Successful Pilot of a CARLA Camp

The first of the CARLA career camps was organized by ICFO on 23, 24 and 25 February 2021. Given the situation of the global pandemic, the initially planned in person camp was adapted to a virtual setting. The camp aimed at inspiring and informing university students and early-stage researchers about career opportunities in photonics, both in industry and academia as well as encourage innovation and entrepreneurship.

Over 150 people attended the event, which consisted of three well-defined blocks through which over 20 international speakers participated. The first was dedicated to introducing the photonics landscape and some of the large initiatives underlying this ecosystem in the EU, as well as tools and approaches to career development provided by professional recruiters and trainers. The second block centered on the photonics community at large, including the participation of 10 professionals in different areas, from industry to academia, as well as in other areas such as publishing and communications, investment and intellectual property. The third block was devoted to innovation and entrepreneurship and included a hands-on workshop in which participants worked in small and diverse groups. Attendees had the opportunity to network amongst themselves, with the speakers and with members of ICFO KTT and HR teams and ICONS, as well as organizations working in different diversity dimensions such as gender, LGTBI and disabilities.

Information about the attendees and their opinions was collected both before and after



the camp. The profile of the attendants was diverse in terms of gender, stage of their career, and cultural backgrounds. 57% identified themselves as women, 43% as men. Over 30 countries were represented. 58% were university students (undergraduate and master), while the rest were PhD students, early-stage postdocs or were in other situations such as returning from a career break. Attendees gave the CARLA camp 4.44 points rating over 5. The degree to which they were clear as to the options available for a career in photonics went up from a starting score of 2.96, to 4.02, reflecting the positive impact of the camp. In general, the camp was well liked and received a lot of positive feedback.

The guided networking sessions, where participants met and talked with speakers and experts in smaller groups, were especially appreciated. In the words of one master student, "Guided networking with experts was awesome". Another undergraduate student admitted, "I'm quite surprised about how interesting, useful and motivational it has been. I didn't expect it to be so cool." In general, the camp was perceived as "an amazing platform to get glimpses of the landscape, current photonics trends, and opportunities", reflecting the intention behind the design and implementation of the CARLA camps.

www.carlahub.eu



The Young Photonics Congress Reaches its Sixth Edition

On March 12, more than 60 people connected to the sixth edition of the Young Photonics Congress, a scientific conference where the spotlight is on photonics-related projects developed by high school students.

The congress took place online for the second time and started with a plenary session with an introduction to photonics and ICFO, followed by flash talks by the ICFOnians Dr Claudia Valdés, Dr Javier Argüello Luengo, Lisa Saemisch and Dr Guillermo Gerling, who talked about their work in photonics, touching different topics such as super-resolution microscopy, quantum simulations, nanotechnology and solar energy.

After that, the participants accessed virtual rooms to meet the high school students and learn about their project by talking to them, as would happen in an in-person poster session. Many ICFOnians joined the event, interacting with the young students and chatting about a variety of topics that reflected the diversity of the research in photonics. The attendants could learn about AI, solar energy, quantum physics as well as the applications of light sensors in Arduino-based devices developed by the students.

For yet another year, the Young Photonics Congress brings together young students and ICFO researchers to inspire the new generation of scientists.



BEYOND ICFO

MEETOPTICS: Making a Frustration a Business Without Missing Science



Bárbara Buades did her PhD in the Attoscience and Ultrafast Optics group at ICFO. **James Douglas** did his PhD in Oxford University before joining ICFO as a postdoc in the Theoretical Quantum-Nano Photonics group.

When they left ICFO, they joined forces and used their experimental and computing skills, respectively, to build MEETOPTICS, a highly specialized optics search platform that now has more than 35.0000 products.

What aspects of transitioning from academia to creating a start-up did you find the most challenging?

J.D: I guess my own naivety. When we started I really thought that it would be a lot easier than it has been. It was a bit overwhelming, you could see how much progress you had made and how much you expected to make, and the huge difference between them. That was pretty tough for me, but I guess this is what happens whenever you do something that is completely new.

B.B: I would say communication was the most challenging part for me. One of my main tasks is to talk with investors, so for me it was hard to learn all this new vocabulary. Words and concepts such as "vertical markets", I had no idea what that meant!

What skills did you learn at ICFO that have been useful for building MEETOPTICS?

B.B: To cope with frustration. Sometimes in the lab things don't work, but you need to be consistent, keep trying and don't give up. Working with investors, I get many no's and few yes'es. It's normal! But like when you have difficulties in the lab, you need to keep going.

J.D: Making a business is, to some extent, very similar to a PhD. You start with lots of excitement, but after a while, reality starts to set in and you realize that maybe you put yourself into something that is really difficult. Maybe you get discouraged, but if you manage to get through it, it's a good preparation for making a business.

GO & FLY

Congratulations to 4 New ICFO PhD Graduates

228 ICFONIANS have successfully defended their theses

Continuing to adapt to the need for social distancing, ICFO's newest PhD graduates defended their theses in a hybrid format, with the thesis committees, colleagues, friends and family supporting them in this important moment from the auditorium and online.

Each of these ICFONIANS has played an important role in ICFO's success and reputation as a leading international research institute. Honoring ICFO's tradition, ICFONIANS celebrate this important personal, professional and institutional milestone and encourage you to Go & Fly! Remember that wherever you go, you will always be a part of the ICFO community.



225 February 11, 2021

MEHMET ZAFER AKGUL
"Environmentally friendly nanocrystals synthesized and processed in ambient conditions for solution-processed solar cells"

TD: ICREA Prof Dr Gerasimos Konstantatos



226 March 24, 2021

NICOLA PALOMBO
"Deterministic control of nanoantenna and single-photon emitter interaction at the nanoscale"

TD: ICREA Prof Dr Niek van Hulst



227 March 25, 2021

PATRICK HÜMBELI
"Machine Learning for Quantum Physics and Quantum Physics for Machine Learning"

TD: ICREA Prof Dr Antonio Acín



228 March 30, 2021

CARLES URGELL FLORES
"New Phenomena in High-Quality Suspended Nanotube Devices"

TD: Prof Dr Adrian Bachtold

Mystery ICFonian

How much do you know about the people you work with?

ICFONIANS are a fascinating group, with hobbies, interests and talents that may surprise you. Have a look around and see if you can guess who this edition's Mystery ICFonian is! Look for the answer in the next edition of ICFONIANS.

1. On part of her work coat, she wears her motto "SONRIE Y ALÉGRAME EL DIA" (Smile and make my day).
2. Her fascination with the human body's ability to think, feel and work is behind her ongoing studies of psychotherapy.

3. She loves to dance.
4. She believes in the power of laughter to heal. She practices and facilitates Laughter Therapy and runs personal growth workshops.

THE LAST WORD

HIGH PROFILE

Joan Gómez Pallarès

General Director of Research,
Government of Catalonia

1. You are renowned for your passion for Science. Can you share with us its source and your motivation?

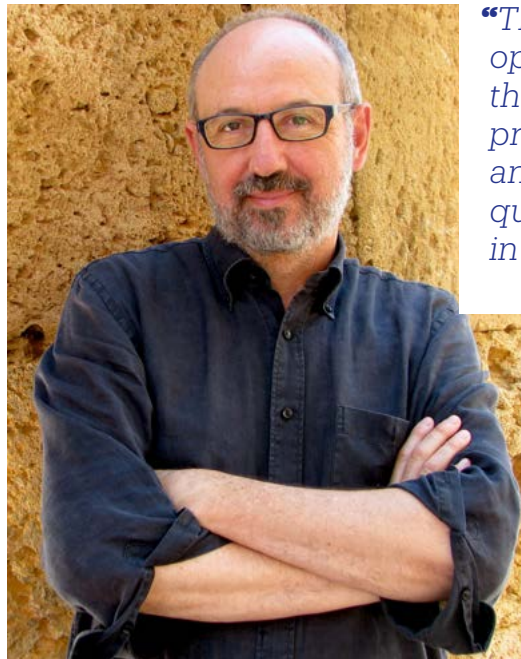
There is a Latin saying "Knowledge for knowledge's sake". My passion for science is stoic: the pursuit of knowledge with no further ambition than to advance your own learning makes you a better person. The more learned you are, the more you will positively influence those who surround you, allowing you to contribute to the well-being and advancement of society.

2. Your own research is in classical philology. What fascinates you from that area of knowledge?

It is a lucid way to know ourselves better thanks to those who came before us. All that we are comes by way of Greece and Rome, and to have this close and at our fingertips (I build my own ideas based on this infinitely rich heritage) is a priceless treasure.

3. What do you see as "competitive advantages" of the research system of Catalonia?

The greatest competitive advantage, that few areas of the world can offer, is that we conduct research of the highest quality in all areas of the knowledge, from prehistory and classical antiquity to the exploration of space, the economy,



"The true ICFOnian spirit, in my opinion, consists of understating that there is only one limit to the progress of knowledge: ourselves and our ability to generate new questions and views of the world in which we live."

demography, quantum physics or the deep understanding of the human body. Here, authentic interdisciplinary research makes total sense. Often, we have lacked institutional and financial support but the strength of the scientific talent from Catalonia is unstoppable. And so is its international attraction, as ICFO demonstrates. They may not even know it, but there are things in the frontier science of the future that could only happen in Catalonia.

4. What are the priorities of the DGR to support research in Catalonia?

First of all, in the five years of implementation of the National Pact for the Knowledge Society (*Pacte*

Nacional per a la Societat del Coneixement) we must reach the same level of structural financing for science as the average of the 27 European states, both in percentage of public financing and the contribution of the private sector to the country's results. Secondly, but in parallel, the Catalan Science Law (*la Llei de la Ciència de Catalunya*) must become a reality in the XIII Legislature, with all of the planning, financing and organization that it entails.

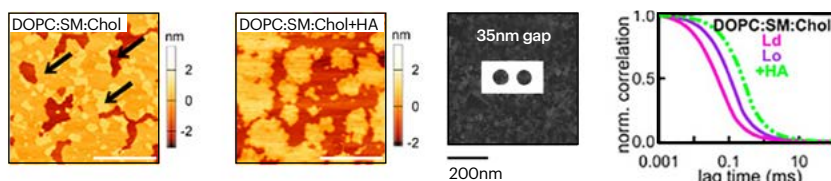
5. ICFOnians are a very international group of women and men. What is your advice to them as the DGR?

The true ICFOnian spirit, in my opinion, consists of understating that there is only one limit to the progress of knowledge: ourselves and our ability to generate new questions and views of the world in which we live. ICFOnians constantly break this personal barrier and so must only do one thing: keep it up!

Science Quiz

The membrane of a biological cell performs many functions. The red/orange AFM images to the right show model membranes consisting of lipids (DOPC and SM) and cholesterol (Chol), with or without a complex carbohydrate (HA). The membranes self-organize into distinct phases, with the HA strongly affecting the μm -scale morphology. Using resonant gold nano-antennas (b/w electron micrograph), an ICFO-IBEC team measured the nm-scale diffusion of fluorescent markers, proving that the HA also organizes the membrane into nano-scale structures.

Impact of Glycans on Lipid Membrane Dynamics at the Nanoscale Unveiled by Planar Plasmonic Nanogap Antennas and Atomic Force Spectroscopy Pamina M. Winkler, Felix Campelo, Marina I. Giannotti, and María F. García-Parajo, *J. Phys. Chem. Lett.* 12, 4, 1175 (2021)



1. What is a plasma membrane ?

- A) The cell membrane
- B) The wall of a blood vessel
- C) An electromagnetic surface wave

2. How long does it take a fluorescent molecule to move by 10 nm in a membrane?

- A) 10s of ns
- B) 10s of μs
- C) 10s of ms

3. What is a plasmon?

- A) A plasma membrane oscillation
- B) A membrane protein
- C) An electromagnetic surface wave

4. If a glycan is a complex carbohydrate, what is a lycan ?

- A) A vampire
- B) A werewolf
- C) A zombie

* Find answers on pg. 2

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to share?

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