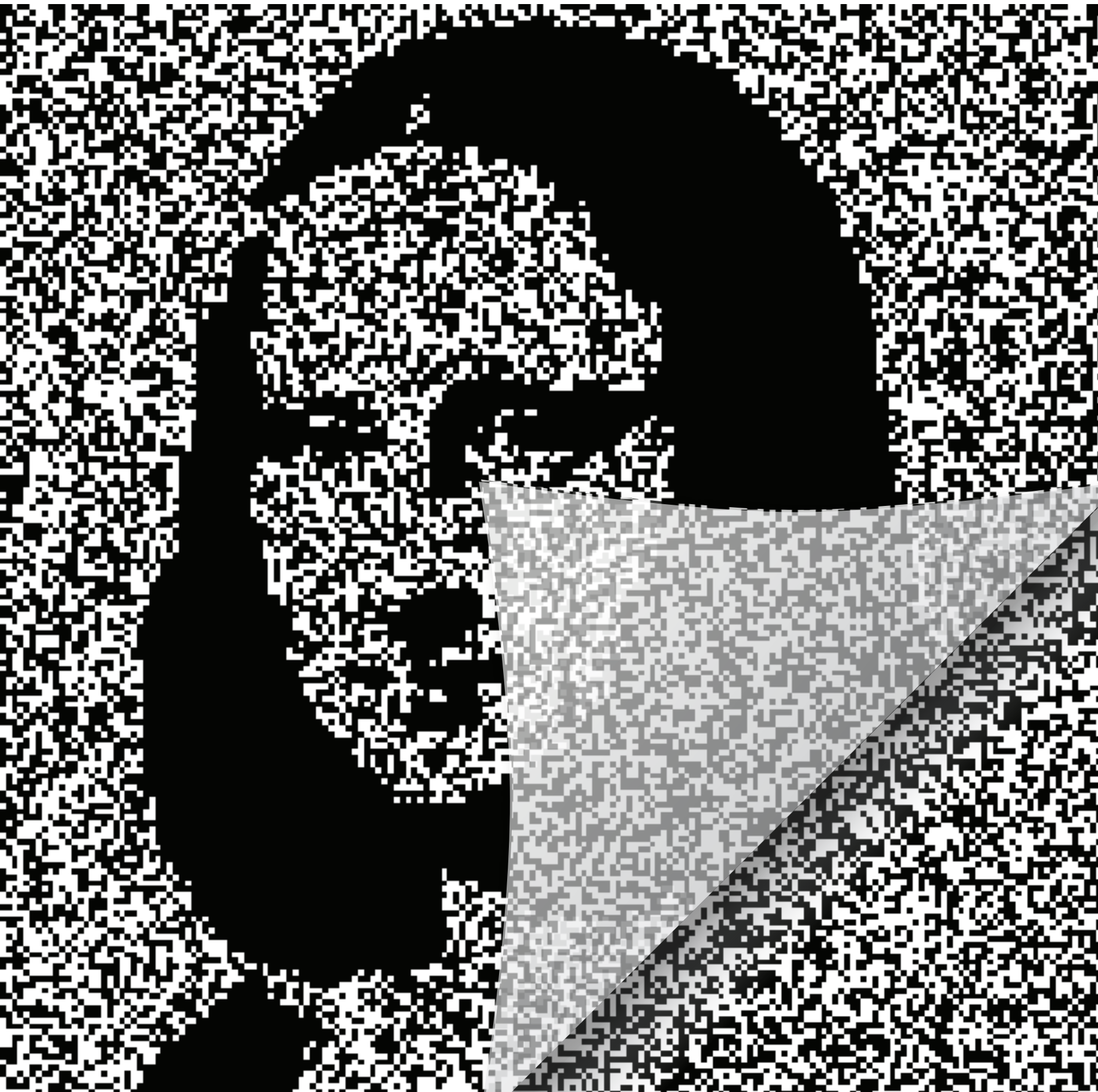
SUMMER 2014

ICFONIANS 20

Community News from the Institut de Ciències Fotòniques



EDITOR'S CORNER

Quantum Potential

Brook Hardwick
Coordinating Editor

Quantum Leap (long running TV series), *Quantum of Solace* (007 film), Quantum Fishing Rods and even Quantum Dishwashing detergent! In spite of the wacky and counter-intuitive nature of the quantum world, it has become common practice to use the word "quantum" to describe almost anything that is powerful or somewhat enigmatic and exotic. Some believe that at least getting the world comfortable with the lingo is a step in the right direction, but is it any wonder that people are a little confused? What can be done to bring some clarity and help improve the reputation of a rapidly growing field of science that is poised to make possible a whole new range of quantum technologies? In this edition of ICFOnians, we celebrate ICFO's role in introducing the quantum world to a new audience and also promoting the field to the next generation of scientists.

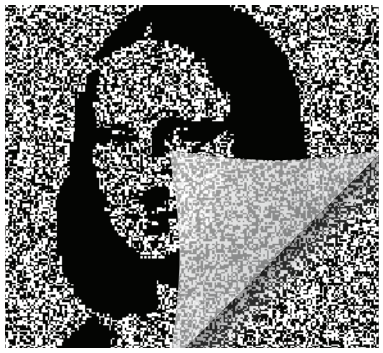
In the spirit of "quantum potential", we highlight two events, tailored to very different audiences. The first is aimed at introducing the possibilities of quantum technologies to the general public. After months of coordination between Barcelona's CosmoCaixa Science Museum and an army of ICFOnians (led by Marta García-Matos), the *Top Science* exhibit opened its doors. ICFO participates with a permanent exhibit on the importance and potential of quantum cryptography, sharing the stage with IrsiCaixa's exhibit on the search for a vaccine for AIDS. When (not if) you visit the exhibit, you will see some familiar faces and will be proud of what ICFO is able to achieve! The second event in this "quantum potential" theme is the YAO (Young Atom Opticians) conference, organized by and for post-graduate students who are already fully aware of the enormous promise of this field. The enthusiasm of the organizers and participants makes it clear that there is a lot of positive energy, work and effort going into future advancements in this area of science.

Even our *Beyond ICFO* section of this edition has a quantum twist! Read on for an update on the life and work of former ICFO Postdoctoral researcher, Gabriel Molina-Terriza, who is now leading his own research group in Sydney at ARC Centre of Excellence for Engineered Quantum Systems.

At ICFO we are proud of what we have achieved to date and of the ICFOnians who have made it all possible. We are convinced of the huge (quantum?) potential of the work that is taking place here and believe in the importance of sharing these advances with society through education, dissemination and collaboration. Opening our doors to the European Union of Science Journalists' Association (EUSJA) and members of Barcelona Global, a citizen's association that is working to make Barcelona the city of choice for top international talent (see our High Profile interview with VP of Barcelona Global, Mr. Gonzalo Rodés), are part of our ongoing effort to get the word out.

Happy Reading!

COVER



In classical cryptography, the one-time pad is the only 100% indecipherable method. The bits that make up the original message (transparent and black pixels in the cover) are encrypted by adding a secret key, which is a random binary sequence of the same length as the message. The message is recovered by reinstating the key. The spy is deterred from searching for the key because he would only be disoriented by any of the many possible messages of the same length. But beware! This method can be used only once since two encodings with the same key can disclose different or revealing information. Quantum Cryptography enables the ultra-secure generation and distribution of this binary key.

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Brook Hardwick, Head of Communications Unit

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European Social Fund

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This newsletter is printed on 100% post-consumer-waste recycled, chlorine-free, and EU eco-labeled paper.

D.L.: B-54464-2008

ICFO NEWS

FIFI World Cup 2014

In the spirit of the 2014 World Cup Championship in Brazil, ICFOnians have come together for the FIFI Futbolin World Cup, organized by ICONS (ICfo Organization and Network of Students). More than twenty teams from research as well as ICFO administration participated in the tournament, making this not only an international competition, but an institution-wide event. Several weeks of intense competition led to a final dual between Antigua and Barbuda and Trinidad and Tobago with the trophy going to Trinidad & Tobago (Pablo Romero and Xavier Elias).

European Journalists visit ICFO

Science journalists from the European Union of Science Journalists' Association (EUSJA) visited ICFO to experience and learn how the science of light and light-based technologies are being applied to the health sector. Over a dozen journalists from Italy, Germany, Belgium, the Netherlands, Russia, Poland, Spain and Denmark toured Barcelona based research institutes CRG, ICFO, BSC and VHIO. All participating centers offered a general overview of their institute, as well as more specific details on the latest research developments and innovations that these centers are carrying out in the health sector.

ERC President tours ICFO

ICFO welcomed Prof. Jean-Pierre Bourguignon, President of the European Research Council (ERC), accompanied by Lluis Rovira, Director of Centres de Recerca de Catalunya (CERCA) and Montse Daban from the Secretary of Universities and Research of the Government of Catalonia. The visit gave ICFO GLs the chance to connect face to face with the European entity that is making possible much of the cutting edge research taking place at ICFO today. In addition to a general overview of the institute's activities offered by ERC Advanced grant recipient Prof. Niek van Hulst, ICFO had the opportunity to showcase two exciting ERC funded research projects.

Highly Cited Researchers

Using indicators taken from InCites Essential Science Indicators, a subset of the Web of Science, Thomas Reuters has launched Highly Cited Researchers. This listing distinguishes researchers who have written the greatest numbers of reports officially designated by Essential Science Indicators as Highly Cited Papers—ranking among the top 1% most cited for their subject field and year of publication (2002 - 2012). ICREA Professor at ICFO, Maciej Lewenstein and Distinguished Invited Professor at ICFO, Ignacio Cirac (MPQ Garching) have earned a place on this list in the category of Physics.

NanoMatMol Prize 2013

The NanoMatMol Prize 2013, awarded annually by the specialized group on Nanoscience and Molecular Materials (NanoMatMol) of the royal Spanish societies of chemistry (RSEQ) and physics (RSEF), was awarded to ICFO PhD student Dr. Alberto Curto, based on the excellent scientific quality of his PhD thesis. Alberto Curto defended his PhD thesis "Optical Antennas Control Light Emission", supervised by Prof. Niek van Hulst, at ICFO on 16th July 2013. Currently Alberto Curto works as a Marie Curie Postdoctoral fellow at Stanford University.

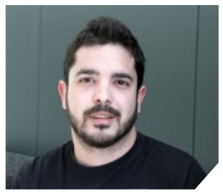
European Innovation Award

The project "A portable diffuse optical neuro-monitor", coordinated by the Medical Optics group led by recently tenured Prof. Turgut Durduran and Dr. Udo Weigel, founder and CEO of the spin-off HemoPhotonics, was awarded the first runner-up prize in the "Best Innovation by a Multilateral Project, Organization or Company" category from the SPIE Photonics Innovation Village. The award was granted in the framework of the annual Photonics Europe Conference of SPIE, the international society for optics and photonics. This monitor, now commercialized by HemoPhotonics, is a diagnostic tool which will allow doctors to better care for many cerebrovascular diseases by non-invasively monitoring blood flow in the brain.

ICFO NEWCOMERS

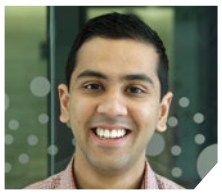
Marco Pagliazzi
PhD Student

Michele Sclafani
Postdoctoral Researcher



Victor Colodrero
Research Engineer

Georg Heinze
Postdoctoral Researcher

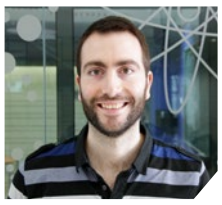


Kamal Ilahibaks
Postgraduate Student

Lluís Hernández Mulà
Undergraduate Student

Peter Wittek
Visiting Scientist

David Alcaraz
Postgraduate Student



Arnau Riera Graells
Postdoctoral Researcher

Camille Lagoin
Undergraduate Student

Vincent Lienhard
Undergraduate Student

Ezequiel Murillo
Postgraduate Student

Ozlem Yavas
PhD Student

Martina Giovannella
PhD Student

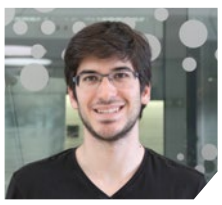
Sergi Beltrán Jorba
Risk Prevention Service

Raúl Pérez Rodríguez
Research Engineer

Bogna Bylicka
Postdoctoral Researcher

Helmut Mäckel
Postdoctoral Researcher

Hugo Pires
Postdoctoral Researcher



Benjamin Haim
Postgraduate Student

Shahrzad Parsa
PhD Student

Ricardo Jiménez
Postdoctoral Researcher

Mafalda Almeida
Postdoctoral Researcher

Eric Puma
Research Engineer

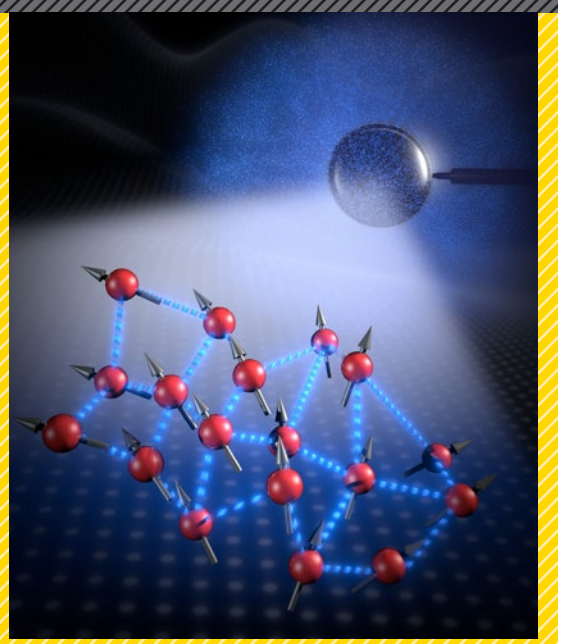
Ivan Supic
Postgraduate Student

Rogerio Fernandes
Visiting Scientist

Many of us joined ICFO or took a new position at the Institute between April and June 2014.

Welcome to ICFO!

LATEST ADVANCES



Nonlocality in many-body quantum systems

In the study "Detecting nonlocality in many-body quantum states" published recently in *Science*, researchers in the groups led by ICREA Professors at ICFO Antonio Acín and Maciej Lewenstein, in collaboration with T. Vértesi from Hungary, designed classes of multipartite Bell inequalities constructed from the easiest-to-measure quantities, the two-body correlators. These inequalities are capable of revealing the nonlocality properties of many-body quantum states, in particular those relevant for nuclear and atomic physics, and can be verified by measuring the total spin components of the particles, opening a new window to experimental detection of many-body nonlocality in physical systems.

Ultra-sensitive nano-chip for early cancer detection

An international team of researchers working together in the SPEDOC FP7 European project led by Prof. Romain Quidant, report in *NanoLetters* on the successful development of a "lab-on-a-chip" platform capable of detecting protein cancer markers in the blood using the very latest advances in plasmonics, nanofabrication, microfluids and surface chemistry. Although very compact (only a few cm2), the device hosts various sensing sites distributed across a network of fluidic micro-channels that enables it to conduct multiple analyses with the help of gold nano-particles and plasmonic resonances. This cancer-tracking nano-device shows great promise as a tool for future cancer treatments based on its reliability, sensitivity, portable nature, and potential low cost.

Steering light in dielectric nanosheets

Osamu Takayama and David Artigas in the research group led by Prof Lluís Torner have published a study in *Nature Nanotechnology* in which they succeeded in steering light guided by nanosheet films, without suffering any sort of losses, using Dyakonov surface waves as opposed to surface plasmons. Plasmons propagating on the surface of a metal tend to show propagation losses. In this study, the researchers showed that 10 nm and 20 nm dielectric nanosheets of aluminium oxide clad between an anisotropic crystal and different liquids are capable of supporting Dyakonov-like modes, where the direction of light propagation can be controlled by modulating the refractive index of the cladding.

The fastest random numbers

The research groups led by ICREA Professors at ICFO Morgan Mitchell and Valerio Pruneri, within the framework of the ERC Proof of Concept project entitled MAMBO, have built the fastest quantum random number generator to date, generating pure randomness at a rate of 43 Gbps. This study was published in *Optics Express*. Quantum random number generators (QRNGs) extract randomness from quantum mechanical processes that are believed to be truly random and unpredictable. QRNGs have important implications for improvements not only in secure communications, cryptography, and quantum key distributions but also in the realm of computer simulations for physical, meteorological and even astrophysical scenarios.

Phase matters

In a study carried out by the Molecular NanoPhotonics group led by Prof. Niek van Hulst and published in *NanoLetters*, researchers have directly measured the optical phase response of various resonant nanoantennas, showing for the first time the phase delay, and connected time delay, developing through the spectral antenna resonance. In this work, they have exploited the second harmonic signal generated by single optical nanoantennas subject to broadband phase-controlled femtosecond pulses to study and tailor the coherent resonance response. Their results reveal that both the spectral phase and the amplitude components associated with the plasmon resonance of arbitrary individual nanoantennas can be accurately determined.

BUSINESS NEWS

Three new companies join ICFO's Corporate Liaison Program

ALTER TECHNOLOGY, IRIS and VLC have recently joined ICFO's Corporate Liaison Program with the aim of establishing long-lasting collaborative relationships with ICFO, building mutual knowledge and trust, and thus boosting mutual benefits.

ALTER TECHNOLOGY is a quality driven company providing procurement, engineering and test services for E.E.E. (Electrical, Electronic and Electromechanical) components and electronic systems, within the space and harsh environment markets, where failure is not an option.

IRIS improves production processes and product quality with custom solutions in the fields of advanced monitoring, automation, data mining, surface activation, decontamination, advanced materials and waste valorisation. They are an international technology transfer and advanced engineering company that combines a solid background in science and research, with an engineering capacity to bring a dynamic and competitive edge to their industrial clients from the agriculture, food, pharmaceutical, chemical and other key sectors.

VLC Photonics offers photonic integration solutions and services, by integrating multiple optical components and systems into a single monolithic chip. Following the fabless design-house model, such photonic integrated circuits are designed and tested at VLC Photonics' facilities, but manufactured through external fabs on the best suited substrate material according to the application at hand (Indium Phosphide, Silicon-on-Insulator, Silica/PLC, or Silicon Nitride). The main applications for photonic integrated circuits are in the fields of communications, optical signal processing, optical sensing and biophotonic applications.

Welcome aboard!

ACCIÓ funds pre-commercial prototype development project

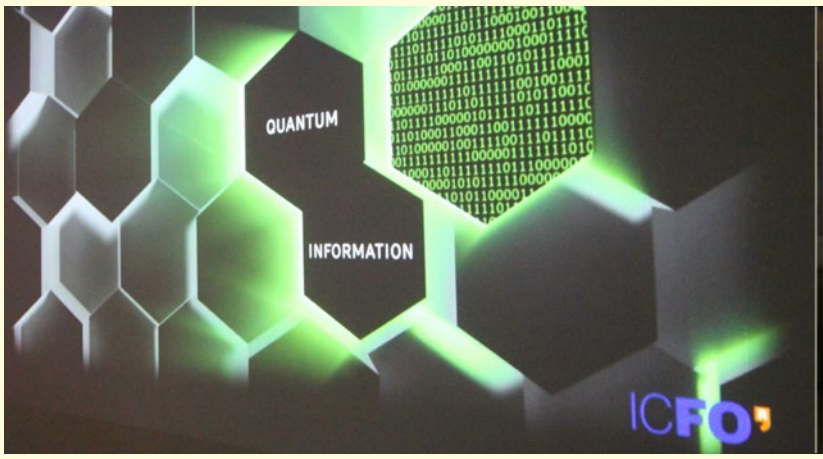
Prof. Majid Ebrahim-Zadeh to lead project through Valtec funding scheme.

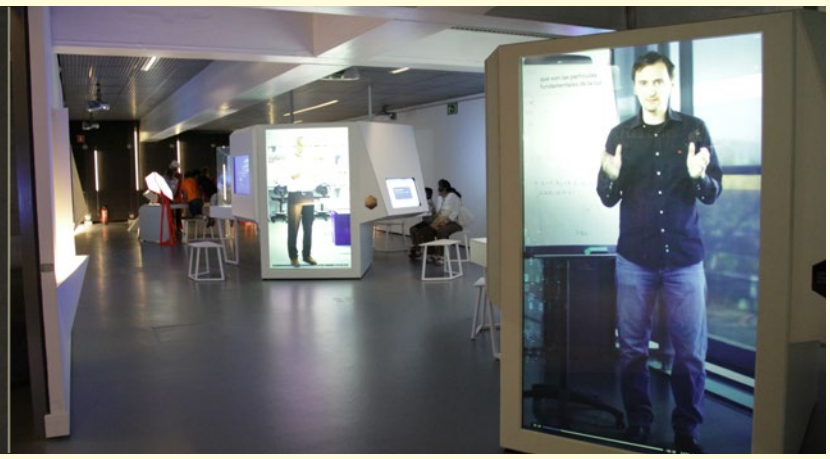
ACCIÓ, the agency for Business Competitivity of the Generalitat de Catalunya (Government of Catalonia), has granted funding for the pre-commercial prototype development of a project led by Prof. Majid Ebrahim-Zadeh through the Valtec funding scheme.

ICREA Prof. Majid Ebrahim-Zadeh, leader of the Optical Parametric Oscillators Group at ICFO will lead the project with the aim of bringing state-of-the-art laser innovations closer to the market. The project consists of building a pre-commercial prototype while assessing its commercial viability. Prof. Ebrahim-Zadeh aims to accomplish a quick transfer of this technology to the market through ICFO spin-off company Radiantis, a world supplier of OPO technology.

The core of this solution is a patented ultrashort *f*s cascade OPO technology that permits ultra-tunable systems in the deep-infrared region, covering for the first time, the spectral range of 4-12 microns. This incredible development opens up a full range of applications in the security & defense, medical and environmental fields.

OUTREACH





ICFO contributes to Top Science

Quantum Keys: The Ultimate Secret

Cryptography is the science of generating secret keys with the purpose of encoding and sending secret messages. The history of cryptography is the battle between the code makers and the code breakers, with code makers being forced to innovate constantly in order to replenish the arsenal of methods that can guarantee the recipient complete privacy against the surveillance of even the craftiest spies. The simple principle of the wax seal –a unique insignia which must arrive untouched– is threatened by anyone that can create a duplicate of the seal. Code breakers always look for a "backdoor key", and eventually find it. Quantum code makers however, have a chance to win this battle, since the laws of quantum physics can guarantee that the unique "wax seal" cannot be duplicated, and that would-be code breakers are detected.

In addition to being the 100% secure method of sending information, quantum cryptography is one of the scenarios chosen by physicists to understand the intriguing laws of quantum mechanics. Concepts like superposition, entanglement, destructive measurements, and randomness, are given a task and an objective, making the perplexing predictions of quantum mechanics somehow more transparent. From a technological point of view, progress in implementing quantum protocols in working systems will obviously benefit other fields of research not necessarily related to cryptography, since the ultimate goal is to better harness and control photons. Quantum cryptography is an example of how the endless quest for privacy has helped to expand knowledge on many frontiers.

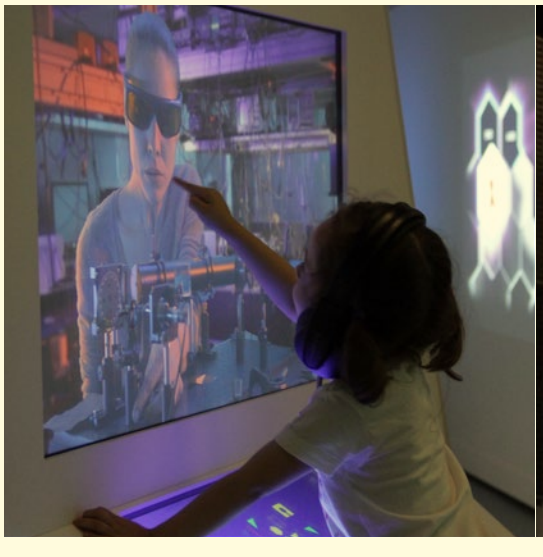
"Top Science is an initiative designed to present cutting-edge research in Catalonia, with a special focus on students and a clear explanation of the implications of this research for society."

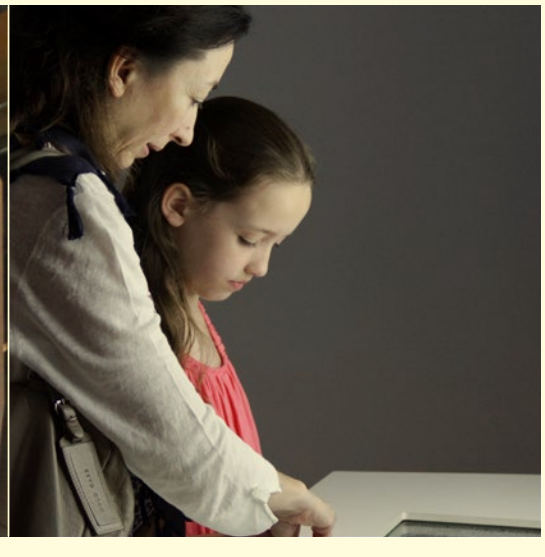
ICFO is now presenting at CosmoCaixa, Barcelona's world-class science museum, in its new permanent space "Top Science", its Space Quest project which aims to install a source of entangled photons for ultrasecure communications at the International Space Station (ISS). Top Science is an initiative designed to present cutting-edge research in Catalonia, with a special focus on students and a clear explanation of the implications of this research for society. ICFO shares the space with IrsiCaixa for AIDS Research, who highlight the scientific journey towards a vaccine for the HIV virus.

The exhibit, which is apt for a general audience, includes explanations outlining the history of secrecy and the basics of ultra-secure communication based on quantum physics. The modules of the exhibit explain the involvement of the four research groups participating in the Space Quest, from the theory- developed in the group led by Prof. Antonio Acin, to the implementations -developed in the groups led by Prof. Juan Torres and Prof. Morgan Mitchell, to the final devices which will be installed in the ISS - designed by the group led by Prof. Valerio Pruneri. These explanations are illustrated by games and interactive devices. The exhibit also serves as a space for daily workshops for high school students.

Contributions from many ICFOnians, including members of the groups led by Professors Antonio Acín, Maciej Lewenstein, Morgan Mitchell, Juan Pérez-Torres and Valerio Pruneri, as well as members of ICFO's Mechanical and Electronic Workshops, were brought together by Marta García-Matos in the KTT team.

The ICFO and IrsiCaixa exhibits are the first of a series of exhibits which will occupy this dedicated space, with more exciting "Top Science" to follow in the future from other leading research institutes in Catalonia.





CONFERENCES

YAO 2014: by and for postgraduate research students

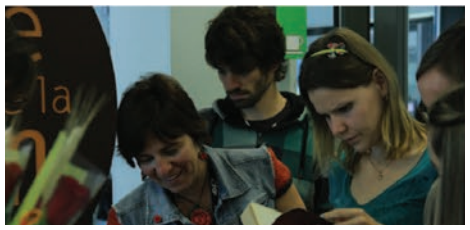
During this week-long event, experimentalists and theorists convene to chat and discuss the latest advances in the field.

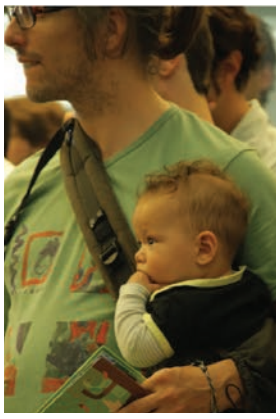
Founded in 1995 in Innsbruck Austria, the Young Atom Opticians conference (YAO) has become a world renowned annual scientific conference, organized by and for postgraduate research students working in the field of optics and atomic physics. The conference's main goal is to create and promote an international community and network of young scientists who work in the field of atom physics, quantum optics, quantum computation and quantum cold gases. During this week-long event, experimentalists and theorists convene to chat and discuss the latest advances in the field through short presentations and poster session discussions.

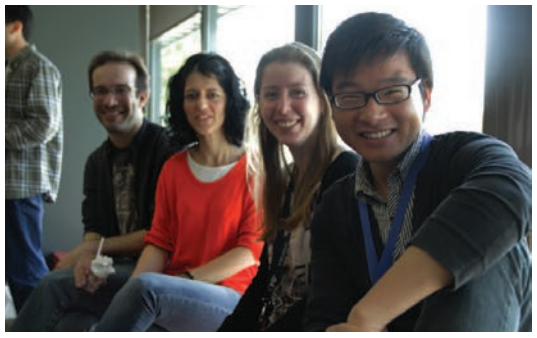
Organized throughout different cities in Europe since the first meeting in Innsbruck, this year the YAO conference was held in Castelldefels. From March 31st to April 4th, ICFO hosted over 110 postgraduate students from more than 20 countries, including Master's students, PhDs and Postdocs, who had the chance to present their research and scientific results, prompting open discussions on hot topics. In addition, attendees had the opportunity to listen to world–leading researchers in the field talk about the latest advances in quantum and atomic optics.

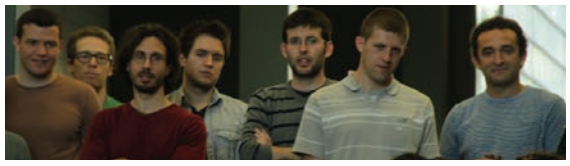
ICFO postgraduate students Boris Albrecht, Naeimeh Behbood, César Cabrera, Giorgio Colangelo, Emanuele Distante, Mustafa Gündogan, Vito Giovanni Lucivero, Daniel Rieländer, Joanna Zielinska, advised by ICREA Professors Maciej Lewenstein and Morgan Mitchell, were in charge of organizing the entire event, which received financial support from the Fundació Catalunya-La Pedrera. The program included not only the traditional invited and oral contributions as well as poster sessions but also a day of lab tours, encounters with company representatives, chats with group leaders, and more informal leisure activities such as a tour of Barcelona, and the YAO 2014 conference dinner. An amazing Quantum DJ sunset party at the Castelldefels beach brought to a close the entire week of fruitful interactions and sharing of ideas that could turn into possible future collaborations.

COMMUNITY PICTURES Sant Jordi @ ICFO









BEYOND ICFO

Gabriel Molina-Terriza:

"One of the joys of the research funding is that I can use it to establish collaborations with some of my old office mates and colleagues"

I have had the privilege of watching ICFO evolve from its conception to the internationally renowned centre it is today. It began when my thesis advisor at UPC, Lluís Torner, was working hard on the dream of a Photonics Centre in the Barcelona area. I finished my PhD and left Barcelona, but returned as an ICFO post-doc in 2004 when it was a bunch of offices on the UPC Campus and a few optical tables in a humid basement. I worked on Quantum Optics experiments with Juan P. Torres and shared an office with Antonio Acín and Sebastián de Echaniz, who became good friends. When we moved to the new building in Castelldefels, there were only around 30 researchers and we all felt part of an exciting new venture. I still don't understand how Nuria Segú kept her cheerful character with all the problems with the laboratories!

ICFO grew, adding covers to the "stairs of fame" (I am proud to have one there), and the science got more and more exciting. The cross-pollination of ideas in this diverse environment was probably key to ICFO's growth… as was the stubbornness of Lluís Torner. It was definitely this environment, plus the inputs from Romain Quidant, Maciej Lewenstein, Lluís Torner and the many visitors who roamed the green corridors and the lecture halls, that allowed me to move to my new research program in Quantum Nanophotonics.

The worst part of this trip was leaving ICFO. The science, the friends, the good and the bad moments… it is difficult not to get attached to ICFO, but it was time for me to move to where I could control my research and study the questions that were brewing in my mind after five years as a post-doc. I got a good offer to come to Australia and in 2009, I joined Macquarie University as a Senior Lecturer, moving permanently in 2010. Soon I got a couple of big Australian projects and a new lab. I am part of one of the prestigious Centers of Excellence of the Australian Research Council: Engineered Quantum Systems (EQuS). I also received a Future Fellowship so that I can concentrate on research. One of the joys of the research funding is that I can use it to establish collaborations with some of my old office mates and colleagues- ask Antonio Acín and Romain Quidant who have already visited me here.

Just as I saw ICFO grow, ICFO witnessed my evolution from a post-doc to a group leader. I now have ten people working with me, including 2 former ICFOnian post-docs: Xavier Vidal and Mathieu Juan. Also, I was married to Ana while at ICFO and our daughter Martina was born shortly before we moved to Australia (hectic times!) Our son, Gabriel, was born three months ago in Sydney. Now the four of us are enjoying life "down-under" in this wonderful city, which like Barcelona has beaches, mountains and good weather. If you are planning to do a PhD or a post-doc abroad, you can have your ICFO away from ICFO here in Sydney.

Gabi's research group at Macquarie University with some familiar ICFO faces.

GO & FLY

76 women and men have successfully defended their theses at ICFO since its founding in 2002 and have helped us to measure what we have learned, how far we have come, and how much we have yet to learn.

These ICFOnians have recently succeeded in defending their PhD Theses. Honouring ICFO's tradition, ICFOnians gather together to celebrate your accomplishments and encourage you to Go & Fly! Remember that wherever you go, you will always be a part of the ICFO community.

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TD: ICREA Professor at ICFO Romain Quidant
April 10, 2014

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'Noise assisted effects in physics and biophysics studied by the optical trapping technique'
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Light Generation and Manipulation from Nonlinear Randomly Distributed Domains in SBN'
TD: UPC Professor at ICFO Prof. Jordi Martorell and Dr. Francisco Rodríguez
June 25, 2014

HIGH PROFILE

Gonzalo Rodés:

"Barcelona is the 3rd most recommended destination in the world for tourism. Imagine this happening on the level of science, IT, and business!"

GONZALO RODÉS- VP of Barcelona Global- a citizen's platform committed to making Barcelona one of the top cities in the world to attract talent and business.

How and why did Barcelona Global come about?
Locals know that Barcelona is a great city and people love to visit, but we want them to stay here to do business- to really become part of the city. Around 4 years ago, we got together about 10-12 groups of experts in their fields, around 300 people from medicine, high tech, industry, start-ups, research,… and we asked each of them what needed to change in Barcelona in their respective areas in the next 10 years to make this city one of the top cities in the world to attract talent and business. Armed with this study, we incorporated *Barcelona Global*, inviting more people and companies to join us to work for these strategic changes.

What is your goal?
We want to learn from the experience of our international professionals, encourage them to feel they belong in our city, and to start a cycle where they help to recommend the city abroad as a great place to do business. According to Trip Advisor, Barcelona is the 3rd most recommended destination in the world for tourism. Imagine this happening on the level of science, IT, and business! *Barcelona Global*'s aim is to make Barcelona one of the top cities in the world to do business, entrepreneurship, and science- not just to visit, but to put down roots.

What does Barcelona have to offer that other global cities do not?
Barcelona has always been a very modern city, a very tolerant city, with a point of friction- and people are attracted to this mix. There is good public transport, a good health system, good schools, a sense of freedom, of tolerance, but no chaos. Not many other cities in Europe can offer all this. We are in Southern Europe but are really well connected with central and northern Europe. We have extraordinary research centers, very good business schools... In Barcelona, everything works, but people who come here still can have adventure!

What role can ICFOnians play in promoting Barcelona as an "innovation capital"?
You can help us to learn what we can improve to meet the expectations of people like yourselves. As a highly mobile group of young people, we would like for you to maintain a relationship with Barcelona after you move on. Also, you can help to spread the word about Barcelona as a great place to live and do research and busines. We want to help you confidently say to your peers who are considering Barcelona, "don't just think about it- GO!"

And ICFO as an institution?
When members of *Barcelona Global* visited ICFO, all of them eager to develop this city, most knew very little about your centre. They found a state of the art centre, ICFOnians speaking many different languages- all within 10 minutes of Plaza Catalonia. Everyone knows that Hollywood is in Los Angeles and when you are in LA, you see and feel Hollywood everywhere! In Barcelona, the average person on the street does not know ICFO and we need to change this and to help the city be more proud and conscious of all that has been achieved here. Barcelona needs a Nobel Laureate!

BARCELONA GLOBAL
a Citizens' Platform for Ideas in Motion

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EASY

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VERY DIFFICULT

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