SPRING-SUMMER 2011

ICFOnians 09

Community News from the Institut de Ciències Fotòniques

EDITOR'S CORNER

Building a NEST at ICFO

ELISABETH PAIN
ICFOnians Contributing Editor

ICFO may still be a young research institute, but it already has a long history. When ICFO was launched by the Catalan Government and the Technical University of Catalonia (UPC), back in March 2002, one of the early tasks for ICFO was to gather a critical mass of scientists and support staff to conduct optics and photonics research at the highest international level. ICFO quickly rose to the challenge.

Originally based in a handful of rented offices in a UPC building in Barcelona, ICFO moved to a state-of-the-art building of its own in the Mediterranean Technology Park of Castelldefels, situated in the outskirts of Barcelona, around three years later. The institute's building, research capacity, and staff have been expanding ever since. In September 2005, when ICFO moved to its new home in Casteldefells, the building occupied some 3,500 m^2, housing around 100 people in 20 research laboratories. By 2009, the building had grown to occupy almost 9,000 m^2 and house some 200 people in 50 laboratories.

Another milestone was reached in ICFO's history last March when the foundation stone of the NEST Cellex building was laid on land adjacent to the main ICFO building. The new state-of-the-art facility of about 4,000 m^2 has been designed to support another 50 ICFOnians at least. The NEST Cellex building will be totally integrated with ICFO's main building for the free exchange of people, ideas, and support services.

Getting a brand new institute off the ground is an achievement that didn't go unnoticed by the Optical Society of America (OSA). OSA is thus to offer the 2011 Leadership Award to ICFO Director Lluís Torner "for leadership and advocacy of optics and photonics, and especially for the creation of ICFO, an excellence center in optical research and a model for successful optics initiatives." As this issue goes to press, ICFOnians have published more than 25 papers in journals of the Nature group -- including a dozen during 2011 alone -- and keep filing new, strategic patents as well as establishing new collaborations with industry.

In this latest issue of ICFOnians, you will find out more about the NEST Cellex program and how it will provide a new home for researchers at the interface of photonics and other scientific disciplines. You will also read about how Ph.D. student Belén Sainz found a new home at ICFO after leaving her native Argentina, and how former Ph.D. student Marc Almendros found support to launch his own start-up company, among many other developments currently unfolding at ICFO.

Happy reading!

COVER

The new NEST Cellex facility currently under construction next to the main ICFO building is to house another 50 ICFOnians conducting interdisciplinary photonics research.

INDEX

Coordinating Editor
Elisabeth Pain

Editorial Committee
Lluís Torner, ICFO Director
Dolors Mateu, ICFO Manager
Silvia Carrasco, ICFO Knowledge & Technology Transfer Director
Laia Miralles i Puig, ICFO Head of Human Resources & Education
Valerio Pruneri, ICFO Group Leader, Optoelectronics
Marta García Matos, ICFO Outreach, KTT
Elisabeth Pain, Contributing Coordinating Editor

Reporting & Picture Research
Marta García Matos, ICFO Outreach, KTT
Elisabeth Pain, Contributing Coordinating Editor
Sergio Simón, Picture Research

Additional Contributors
Silvia Carrasco, ICFO Knowledge & Technology Transfer Director
Marc Almendros, CEO, Signadyne Spain S. L.

Pictures by
ICFO
R. Josa
Xavier Farré
E. Blanco
Marc Almendros
Tinou Bao
A. Sánchez-Villalva

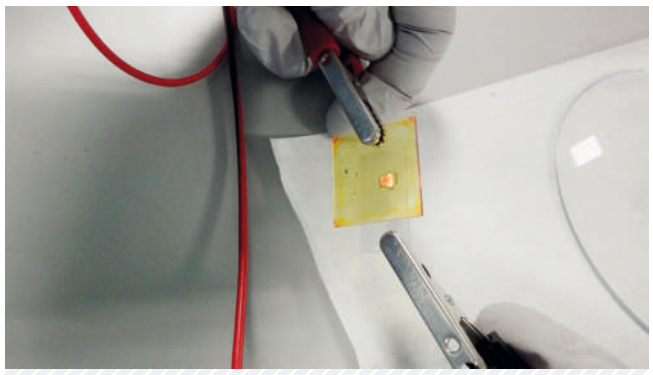
Design & Layout
Lluís Campos, Logo designer
Tòfol Cruz, Design & layout

ICFO Institut de Ciències Fotòniques

ICFO-The Institute of Photonic Sciences
Mediterranean Technology Park
Av. Carl Friedrich Gauss, 3
08860 Castelldefels | Barcelona | Spain
Phone: 93 553 4001
Email: icfonians-newsletter@icfo.es
Web: www.icfo.es

D.L.: B-54464-2008

ICFO NEWS



Leading Researchers

City of Barcelona Awards

This year the Barcelona City Council's Award for recent advances in scientific research goes to ICFO group leaders Niek van Hulst and Romain Quidant for their collaborative development of unidirectional optical nanoantennas. Niek van Hulst leads the Molecular Nanophotonics Group at ICFO, with Romain Quidant leading the Plasmon Nano-optics Group. Both researchers are funded by the Catalan Institute for Research and Advanced Studies (ICREA) and the European Research Council (ERC).

Young Talent

Photonics21 Student Innovation Award

ICFO Ph.D. student Dhriti Sundar Ghosh has received the 2011 Photonics21 Student Innovation Award for his work on ultrathin metal films for energy-efficient photonics. Dhriti, who works in the Optoelectronics Group led by ICREA Professor Valerio Pruneri, shares the prize with Oriol Bertran-Pardo of Alcatel-Lucent Bell Labs in France.

IONS Most Creative Presentation Award

ICFO Ph.D. student Can Yao has won the Most Creative Presentation Award at the 9th International OSA Network of Students (IONS) conference held in Salamanca last April. Can is a Ph.D. student in the Organic Nanostructured Photovoltaics Group led by Jordi Martorell. She delivered her scientific presentation in the form of a poem illustrated with images of experimental results and computer simulations. The research was done in collaboration with ICFO research fellow Francisco Rodríguez.

High School Research Projects

During 2010, ICFO guided 13 high school students through 11 different research projects in the fields of quantum optics, emerging lighting, lasers, biophotonics, and optical tweezers. The students performed their experiments under the guidance of ICFO researchers in the Optical Tweezers Group led by ICREA Professor Dmitri Petrov, the Organic Nanostructured Photovoltaics Group led by Jordi Martorell, and the Ultrafast Imaging and Nonlinear Microscopy Group led by Pablo Loza-Alvarez. The program is coordinated by Dr. Alejandra Valencia of the Outreach Team in the Knowledge and Technology Transfer (KTT) Unit.

New ICFO Ph.D. Graduate

Marco Koschorreck graduated earlier this year with a thesis on quantum metrology using cold atomic ensembles. During his Ph.D., Marco developed new techniques to manipulate atomic quantum states which allow precision measurements beyond the standard quantum limit. His thesis was supervised by Morgan Mitchell, leader of the Quantum Information with Cold Atoms and Non-Classical Light Group at ICFO.

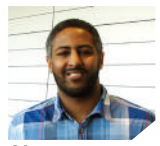
ICFO NEWCOMERS

Alessio Celi
Research Fellow

Elisabet Xifre
Research Fellow

Johannes Johansson
Postdoctoral Researcher

Nicolas Godbout
Visiting Scientist



Aboma Merdasa
Ph.D. Student

Xu Wang
Visiting Scientist

Abhinand V. Sreelatha
Postgraduate Student

Fiona Beck
Postdoctoral Researcher

Christopher Galloway
Postdoctoral Researcher

Giorgio Colangelo
Ph.D. Student

Soren Gammelmark
Visiting Scientist

Bruno Julia Díaz
Postdoctoral Researcher

Carmelo G. Rosales
Ph.D. Student

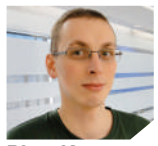
Badr Ammour
Undergraduate Student

Sergio Simón
Graphic Designer

Javier Rodríguez
Research Fellow

Albert Carrilero
Research Engineer

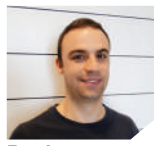
Vito Giovanni Lucivero
Ph.D. Student



Piotr K. Migdal
Ph.D. Student

Jacob Licea
Visiting Scientist

Thierry Le Goff
Project Manager ITF



Paolo Dallocchio
Visiting Scientist

Esteban Bermúdez
Ph.D. Student

Daniel Pérez Gumà
Postgraduate Student

Candan Aydin
Undergraduate Student

Klaas-Jan Tielrooij
Postdoctoral Researcher

Pablo Romero
Postdoctoral Researcher

Enrique Sánchez
Ph.D. Student

Olivier Tieleman
Visiting Scientist

Ferran Martin
Postgraduate Student

Erwan Negre
Undergraduate Student

Saeed G. Sabouri
Visiting Scientist

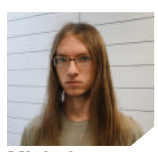
Michäel Hemmer
Postdoctoral Researcher

Carlo Manzo
Postdoctoral Researcher

Claudia P. Valdés
Ph.D. Student

Ariadna Martínez
Postgraduate Student

Boris Malomed
Visiting Professor



Michal Kotowski
Postgraduate Student

Marcin Kotowski
Postgraduate Student

Efraín Solarte
Visiting Professor

Irati Golvano
Postgraduate Student

Jana Nieder
Research Engineer

Sebastián A. Thompson
Postdoctoral Researcher

David Merino
Postdoctoral Researcher

David Wilby
Visiting Scientist

Tomasz Sowinski
Visiting Scientist

Brook Hardwick
Brand Manager

Manuel A.Martínez
Postdoctoral Researcher

Anna Oddone
Research Engineer

Anna Przysiezna
Visiting Scientist

Pawel Mazurek
Visiting Scientist

Gerard Marull Paretas
Undergraduate Student

Radostin Pavlov
Postgraduate Student

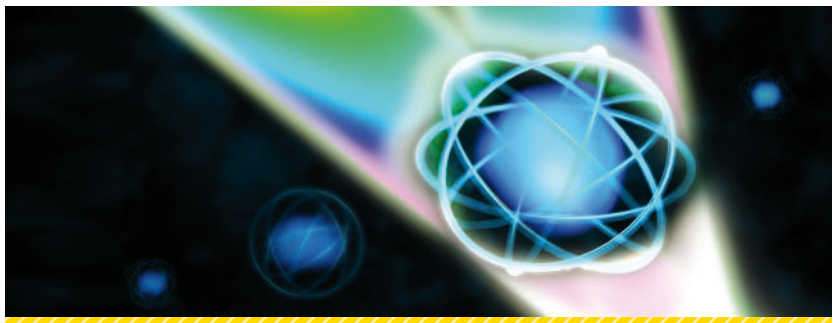
Julia Fekete
Postdoctoral Researcher

Igor Swiecicki
Undergraduate Student

Many new people joined ICFO or took a new position between January and May this year.

Welcome to ICFO!

LATEST ADVANCES



Quantum Simulators

Ph.D. student Philipp Hauke and leader of the Quantum Optics Theory Group and ICREA Professor at ICFO Maciej Lewenstein presented a new theoretical proposal on how ultracold atoms in hexagonal lattices may be used to simulate solid state systems. The advance represents an important tool for quantum simulation as well as a first step toward the realization of graphene-like structures with ultracold atoms. The work, published in *Nature Physics*, was done jointly with scientists at the Institute of Laser Physics in Hamburg, Germany.

Twisted Light

ICFO researchers helped develop a mathematical approach for the detection of intriguing astrophysical objects such as spinning black holes. The technique is based on a relativistic effect that twists the light emitted by sources near black holes and gives them a unique, observable 'fingerprint'. The result also opens the way to new observational tests of Einstein's general theory of relativity. The research was done by postdoctoral researcher Gabriele Anzolin in Morgan Mitchell's Quantum Information with Cold Atoms and Non-Classical Light Group and former ICFOnian Gabriel Molina-Terriza, now at the Macquarie University in Australia. The work, which appeared in *Nature Physics*, also enjoyed the collaboration of researchers at the University of Padua in Italy and the Swedish Institute of Space Physics in Uppsala.

Quantum Information

The Quantum Information Theory Group led by ICREA Professor Antonio Acín recently contributed to two *Nature Communications* papers. In one paper, Antonio Acín, together with former ICFOnian Mafalda Almeida and researchers at the National University of Singapore, described a new scenario for the study of non-locality in quantum networks. The second paper provided a general security proof for use in communication through quantum cryptography, and was co-authored by research fellow Lluis Masanes and former ICFOnian Stefano Pironio, now at the Université Libre de Bruxelles in Belgium.

Green Generation

ICFO research on alternative ways of generating coherent green light became 'World News' in *Laser Focus World*. Motivated by the lack of suitable laser materials in the green region, ICFO researchers found a new approach for generating green light (with a wavelength of 532 nm) using a laser source of double the wavelength -- a process known as Second Harmonic Generation (SHG). The team improved current limitations of SHG by using a multi-crystal scheme that provides coherent green light with a record efficiency of 56%. The work was originally published in *Optics Letters* by ICREA Professor and Optical Parametric Oscillators Group Leader Majid Ebrahim-Zadeh, Ph.D. students Chaitanya Kumar and Kavita Devi, and former ICFOnian Goutam Kumar Samanta.

Ultra-sensitive Measurements

Physicists at ICFO have designed a measurement system that allows for the first time to reach beyond the 'Heisenberg limit' -- the ultimate limit for ultra-sensitive measurements. The system, which relies on ultra-cold atoms, beats traditional interferometers by a factor of 10. The result is of fundamental importance for sensitive measurements such as gravitational wave detection, magnetic measurements for medical imaging, and atomic clocks for precise navigation. The paper was published in *Nature* by Ph.D. student Mario Napolitano, postdoctoral researcher Robert Sewel, and leader of the Quantum Information with Cold Atoms and Non-Classical Light Group, Morgan Mitchell.

BUSINESS NEWS

Corporate Liaison Program Members

ICFO welcomes four new partners to its Corporate Liaison Program (CLP). The New York State-based multinational **Corning Inc.** corporation is the world leader in specialty glass and ceramics. Drawing on 150 years of knowledge in materials science and process engineering, Corning produces keystone components for high-technology systems to be used in consumer electronics, telecommunications, and life sciences applications. ICFO and Corning recently signed a sponsored research agreement to exploit the opportunities offered by ICFO's ultra-thin metal film technology for Corning's advanced glasses for tactile displays.

Hamamatsu Photonics K.K. is a global company headquartered in Japan with over 50 years of expertise in the manufacturing of optoelectronic components. The company's corporate philosophy stresses the advancement of photonics through extensive research and yields innovative, high-quality products for a wide range of applications. Hamamatsu's cutting-edge products and knowhow in advanced imaging and detection complement very well ICFO's super-resolution imaging and detection research activities.

Emxys S.L. is a SME focused on R&D in the aerospace sector. Located near Alicante in Spain, the company is specialized in advanced electronics design for space instruments, data acquisition, and control systems. Emxys provides high-performance solutions for the space, defense, and industrial automation markets as well as for scientific research. Emxys currently collaborates with ICFO on two research projects funded by the European Space Agency.

Finally, ICFO's start-up company **Signadyne Spain S.L.** is devoted to developing and commercializing high-performance electronics for control, test, and measurement systems for scientific research and industrial applications. Behind this new venture is former ICFOnian and CEO of the new company Dr. Marc Almendros (see page 7).

CORNING

emxys embedded instruments

HAMAMATSU PHOTON IS OUR BUSINESS

Signadyne

Advanced Head-Up Display Technology

The Mobility & Automotion through Advanced Transport Networks (MARTA) project was one of 16 research initiatives funded by the Spanish Centre for the Development of Industrial Technology in 2005. Coordinated by the multinational corporation Ficosa, the project aimed at helping the Spanish Intelligent Transport System face the security, efficiency, and sustainability challenges found in today's European, and Spanish, society. The presentation of the project's final outcomes took place in Barcelona in February, with Spanish Science and Innovation Minister Cristina Garmendia and Ficosa President Josep Maria Pujol attending the event.

ICFO took part in the two-day program with a demo of the advanced head-up display technology developed by research engineer Daniel Infante and research fellow Davide Janner in the Optoelectronics Group led by ICREA Professor Valerio Pruneri. The work was done in collaboration with ADTelecom, Seat, and FICOSA. The alternative light-based, low-cost, and high-performance head-up display technology for easier and safer driving was commended with a special mention at the Barcelona International Motor Show 2011 later in May. ICFO is now securing the next round of funding to develop the technology into a commercial product.

Spanish Science and Innovation Minister Cristina Garmendia tried out ICFO's Advanced Head-Up Display Technology during the MARTA closure event

NEST CELLEX

ICFO starts construction of the NEST Cellex building

The 4,000 m^2 NEST Cellex building will feature state-of-the-art laboratories, functional workstations, and open spaces to foster the exchange of people, ideas, and knowledge.

On March 14, ICFO laid the foundation stone of the new NEST Cellex building, which is to house a unique research program exploring the role of photonics in other scientific disciplines like medicine, information technologies, renewable energy, nanotechnology, and environmental studies. Altogether, the building is to host another 50 researchers and technical staff by completion in winter 2012 -- just in time for the celebration of ICFO's 10th anniversary.

The NEST Cellex building is located next to ICFO's main building, on land given by the Catalan Government. The construction has been made possible by a generous donation from the Fundació Privada Cellex Barcelona, which will also support the launch of new research projects. ICFO Director Lluís Torner and Ignacio Cirac, Distinguished Invited Professor at ICFO and Director of the Theory Division at the Max Planck Institute of Quantum Optics in Garching, Germany, jointly run the program.

Attending the March 14 ceremony were, from left to right: Mayor of Castelldefels Joan Sau, President of the Catalan Government Artur Mas; President of Fundacio Privada Cellex Barcelona Dr. Pere Mir i Puig; and Catalan Minister of Economy and Knowledge Andreu Mas-Colell

Four NEST Fellows have already joined the program as Junior Group Leaders

One of the hallmarks of the NEST Cellex program are tenure-track positions for early-career researchers with enormous talent and potential, on par with most other world-class research institutions. Four NEST Fellows have already joined the program as Junior Group Leaders:

Frank Koppens's group investigates nanoscale optoelectronic devices with an emphasis on tailoring strong light-matter interactions between single quantum systems and strongly confined optical fields and exploiting the novel properties of graphene. Frank did a postdoc at Harvard University in Cambridge, Massachusetts before joining ICFO, in June 2009.

Gerasimos Konstantatos is exploring novel nanomaterials and devices for renewable energy applications and sensitive optical sensing using solution-processed semiconductors. Gerasimos joined ICFO in September 2009 following a postdoc at the University of Toronto in Canada.

Melike Lakadamyali's research goal is to develop advanced fluorescence imaging techniques that can be used to answer fundamental questions in biology. Melike joined in January 2010 after a postdoctoral fellowship at Harvard University's Center for Brain Science in Cambridge, Massachusetts.

Darrick Chang is currently finishing a postdoc at the Institute for Quantum Information at Caltech in Pasadena, California. Darrick's research program at ICFO will focus on developing novel tools to understand and manipulate light and light-matter interactions at the quantum level.

IN FOCUS by Marta García Matos

Belén Sainz:
People in the Human Resources Department "were really a big support for me"

Belén Sainz has always loved solving problems in math and fundamental physics. This led her to leave her native Argentina a couple of years ago to start a career in quantum information science at ICFO. Changing country is a big leap, but Belén found at ICFO a welcoming and supportive community that she says helped her smooth the transition.

Belén got hooked on quantum information science when she was studying physics as an undergraduate student at the National University of Córdoba in Argentina. As she looked for a place to enter the field, one of her professors put her in touch with Fernando Stefani, who today leads the Nanomaterials Photonics Group at the University of Buenos Aires. Fernando, who had spent some time at ICFO doing postdoctoral research in the Molecular Nanophotonics Group led by ICREA Professor Niek van Hulst, recommended ICFO for being a place that is young, dynamic, and full of projects, Belén recalls.

So, after graduating and finishing first of her class -- an achievement that won her an award from the Banco Santander Río in Argentina -- Belén moved over to Spain, in September 2009. Belén was based at ICFO right from the start, but she spent most of her first year studying for a Master's degree in photonics jointly offered by the University of Barcelona, the Autonomous University of Barcelona, and the Technical University of Catalonia.

Then, in September 2010, Belén started a Ph.D. in the Quantum Information Theory Group run by ICFO Group Leader and ICREA Professor Antonio Acín. "As a first step in my thesis, I'm studying entanglement and non-locality properties of bipartite quantum systems," Belén says. "This problem is very challenging, and that's what I like most."

Working and living in a new country was a big change. By her final year at the University of Córdoba in Argentina, Belén knew everyone in the physics faculty and the building felt like her second home, she says. But when she arrived at ICFO, Belén was struck by the warm welcome she received from the Human Resources Department in particular. "Sometimes, when you're new in some other country, it takes time to adapt to the local culture and customs, even if you speak a similar language," Belén says. People in the Human Resources Department "were really a big support for me." They helped Belén sort out her visas, get a Spanish bank account, and find a place to live, which gave her more time to then focus on settling in her work and personal life, Belén says.

Today, Belén already has made friends in each of the different groups at ICFO, and when she gets tired of math, she studies Japanese as a way of relaxing, she says. That's how she got to know Osamu Takayama, a Ph.D. student at ICFO in the Nonlinear Optical Phenomena Group led by Lluís Torner. Osamu, a former president of the ICFO Organization and Network of Students (ICONS), then introduced Belén to ICFO's table football tournaments and broader social life.

It's been less than a year since she began her Ph.D., but Belén already feels that she has also started maturing as a scientist. She can now envisage a more holistic approach to fundamental physics in which theoretical problems do not only have a new, perhaps even philosophical depth but are also closely related to experimental aspects. "We'd like to eventually team up with experimental groups, which also motivates me," she says. Above all, Belén has been enjoying the freedom to explore new horizons. She likes "the freedom of a researcher to choose, up to some extent, what to study, when, how, and where."

**Belén Sainz is a Ph.D. student in the Quantum Information Theory Group led by ICREA Professor Antonio Acín at ICFO.*

COMMUNITY PICTURE

Young researchers at ICFO recently celebrated the Catalan culinary tradition of barbecuing green onions in a 'Calçotada'. From left to right: Fabian Steinlechner, Daniel Infante, Marc Jofre, and Osamu Takayama

BEYOND ICFO By Marc Almendros

Marc Almendros: "I realized that an electronic device, which I was designing for controlling our experimental setup actually had some commercial potential"

I love research. You need creativity to solve complex problems, and searching for such creativity is a challenge I quickly got addicted to. This is why, from a very young age, I knew I wanted to study for a technical degree. What I had not foreseen, however, is that research would take me to a less-traveled road full of different -- yet just as exciting -- opportunities.

I first obtained an engineering degree from Ramon Llull University's La Salle engineering school in my native Barcelona and continued with a Ph.D. program at the Technical University of Catalonia (UPC). I did my Ph.D. work at ICFO, which I decided to join after reading the national newspaper *El País*. There, I saw an article about the research being done at ICFO by Group Leader Jürgen Eschner and his Quantum Optics and Information with Single Atoms and Photons Group in the applications of cold atoms in quantum communication and processing. I found the research fascinating, so I sent Jürgen an email and we met up for an interview. This was the beginning of my adventure at ICFO, and one of the best decisions of my life.

Back when I started my Ph.D., in 2005, ICFO was still a very young institute, but one could already tell it was a special place. Led by top researchers and administrative staff, ICFO grew rapidly from having some 30 researchers working in a handful of offices to taday's more than 200 researchers working in a shiny building full of laboratories. I can proudly say that I witnessed this transformation, and I learned a lot from working in such an environment. In particular, the international culture and cutting-edge research I got exposed to at ICFO helped me grow both professionally and personally.

My experience at ICFO also soon opened new horizons for me. While I was working on my Ph.D. project, which focused on ion trapping and quantum communications -- we were the first lab to build an ion trap in Spain -- an unexpected opportunity arose. There came a point when I realized that an electronic device, which I was designing for controlling our experimental setup actually had a much broader range of applications, and hence some commercial potential. This got me thinking about setting up my own technology startup, a possibility that the ICFO+ 'From Science to Business' training program later helped me to see as both real and feasible. Then, in 2009, I started collaborating with Dr. Silvia Carrasco from the Knowledge and Technology Transfer (KTT) Unit at ICFO, helping Business Development Officer Llorenç Solà with the technical assessment of another startup.

This hands-on experience gave me the final push to make the jump, and everything has been going very fast since. I started a two-year MBA program at the ESADE Business School in Barcelona in 2009 and obtained my Ph.D. in 2010. That same year, I got money from the Catalan Government to develop a commercial prototype of my electronic device, which Signadyne's Chief Technology Officer Néstor Oliverio and other ICFO engineer Ramon Chalmeta helped me develop. At the beginning of 2011, three final-year undergraduate students -- Jordi Mir, Oriol Romaguera, and Daniel Bernardino-- also joined the company.

Today, we are almost ready to deliver our first product to its first client, we exhibited our work in the world's most famous photonics trade fair, and we have reached a point where we can start looking for investment funds. ICFO's support, coming from Jürgen, Silvia, Dr Lluís Torner, and Mrs M. Dolors Mateu, was crucial to our early success.

As in any startup adventure, our future is full of uncertainties. But I find many similarities between these uncertainties and those one can find in research. I discovered that, in the business world, there is just as much space for passion and creativity and, like in academia, the possibilities for success are just limitless.

**Marc Almendros is CEO of Signadyne Spain S. L. in the ICFO business incubator.*

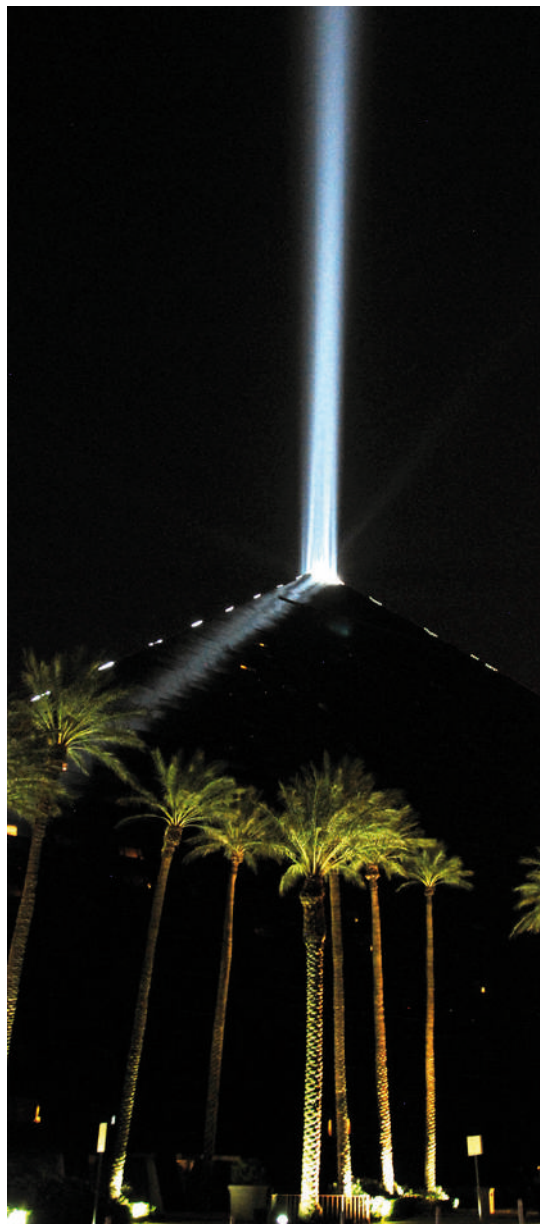
CURIOUS FACT

The Luxor's Sky Beam in Las Vegas: the strongest spotlight in the world

If you ever make a trip to Las Vegas, make sure you take a night drive along the Las Vegas Strip. This stretch of road about 7 km long near the City of Las Vegas harbors many of the largest hotels and casinos in the world, but one in particular that will draw your attention is the Luxor Hotel and Casino.

Designed by architect Veldon Simpson and opened in 1993, the 30-floor hotel was built in the shape of a pyramid and has a light beam rising from its top. The Luxor's Sky Beam represents more than 42 billion in candlepower, which won it the reputation of being the strongest spotlight in the world. The engineers who designed the beam used 39 Xenon lamps and curved mirrors to collect the light into what the hotel calls a "Stairway to the Stars."

Not that you actually need to go to Las Vegas to see it. The Luxor's Sky Beam is visible to airplanes passing as far as 400 kilometers away from Las Vegas. And, the hotel also claims, you can spot the Luxor's Sky Beam from outer space: the light emitted by the beam is deemed to be sufficient for an astronaut to read a newspaper 16 kilometers into space.



HIGH PROFILE

Konstantin Novoselov:

With graphene "We have such a variety of different properties, and all of them are superior to the properties of other materials"

Russian born Konstantin Novoselov is a Professor of Physics at the University of Manchester in the United Kingdom. In 2010, Professor Novoselov shared the Nobel Prize in physics with Professor Andre Geim "for groundbreaking experiments regarding the two-dimensional material graphene." At age 36, Professor Novoselov became the youngest physics laureate since Brian Josephson in 1973.

How did you first become interested in physics?
I've always been a rather technical boy. As a kid I was always playing with some electrical toys. I just made those myself. And then my physics teacher allowed me free rein with the equipment in our teaching lab at school, so I was playing with those.

As it happened, you also started working on graphene while you were doing a Ph.D. with Professor Geim, who is famous for encouraging young scientists in his lab to play around in what he calls "Friday night experiments." How did graphene go from being a slightly crazy research idea to becoming a Nobel Prize discovery?
We usually have a number of those small projects where we try to do something, and if it works, it works, if it doesn't work, it doesn't work. As a matter of fact we never were planning to discover graphene. We were trying to make a transistor out of graphite, and we were quite lucky because the very first device worked, although very poorly, and then to improve its performance we tried to make it thinner and thinner and thinner. We used the same cleavage technique over and over again. You pick up a piece of graphite, you attach a piece of Scotch tape on it, peel it off. What you get is a thin layer of graphite on the Scotch tape, and then when you attach it to any substrate the very bottom layer stays on the substrate. We basically searched the substrate and tried to find those pieces of graphite which looked thinner. And eventually we came to graphene. This whole process took us about a year.

What surprised you most about graphene?
Exactly this, that it was such a simple technique and yet we managed to get such high-quality samples. But there were many surprises on the way.

What were those other surprises?
That graphene holds so many unique properties. It is the strongest material mechanically. It's the thinnest material. It's the most impermeable material. And its electronic properties are really incomparable to other conductors because its charge carriers are moving through the crystal mimicking relativistic particles. We have such a variety of unique properties in one simple crystal, and all of them are superior to the properties of other materials.

And what about graphene's optical properties?
Graphene is a very thin material and yet it absorbs quite a sizable fraction of light, which is 2.3%, and this by itself it's quite surprising already. And this number is not given by any material parameter. It's just given by a combination of fundamental constants. It's pi times the fine-structure constant. And so, it is so optically active because there is a symmetry between charge carriers in the valence bands and in the conduction bands.

What do you see as the most exciting graphene-related questions in optics research?
Probably the question about interactions and many-body effects in graphene is one of the most interesting for me. Another one is the relaxation of the quasiparticles in graphene after optical excitation. And then there is also graphene bilayer, whose optical spectrum is quite different, and it can be controlled by the electric field, which is also very, very unusual. But optics is a vast field, and there are many questions which can be addressed.

SUDOKU by www.sudoku-puzzles.com

EASY

	6				2		5	
8		3	4		5			2
1		2			6	9		3
3				6	7			
	9	6				7	3	
			9	1				6
5		1	3			2		4
4			6		1	3		8
	3		8				9	

MEDIUM

		3	7			8	6	
7						1		5
	8			3				2
	7				9	4		
			4		5			
		6	2				1	
5				2			9	
6		8						3
	9	2			4	7		

DIFFICULT

		4	2					
9		6						
	3			7			9	4
8					4	5	2	
		5		9		1		
	7	9	5					3
1	2			6			8	
						7		2
					1	9		

VERY DIFFICULT

		7		6	1			
		6	9			8		
			8				3	6
		2	7			1		4
	3						6	
1		9			5	3		
5	7				3			
		3			4	2		
			5	9		7		

Want to subscribe? Have you got news to share?

Whether you'd like to subscribe to **ICFOnians**, change your email address, or have some comments and ideas for future content, we'd love to hear from you!

To register for subscription and read back issues of ***ICFOnians***, please visit the ICFO Website **www.icfo.es**.

To get in touch, please send us an email to**:** **icfonians-newsletter@icfo.es** indicating your name, email address, and institution.