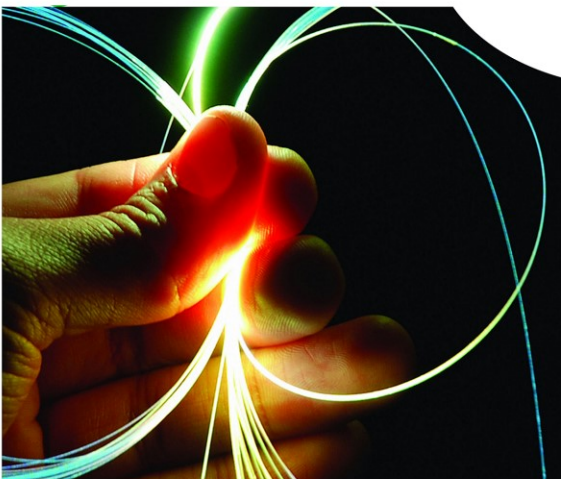


International
School on

Light

Sciences and
Technologies



June 25-29, 2018

Santander, Spain

Core: Light in Communications and Sensing



DIRECTOR:
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International School on Light
Sciences and Technologies ISLIST
June 25-29, 2018, Santander, Spain

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COLLABORATORS





Summary

Photonics is the science and techniques of generating, controlling, propagating, storing and detecting light waves and photons, which are particles of light. Photonics is the field of Light Sciences and Technologies.

Light plays a vital role in our daily lives and is being an imperative cross-cutting discipline of science in the 21st century. It has revolutionized medicine, made possible international communication via the Internet, enabled sustainable development and provided solutions to global challenges in education, energy, environment and agriculture. It continues to be a key discipline to link cultural, economic and political aspects of the global society. Today, it is widely accepted that the present century will depend as much on Photonics as the 20th century depended on electronics.

The United Nations Organization (UN) has recognized the **key or essential** role of Light Sciences and Technologies to raise global awareness and proclaimed 2015 as the International Year of Light and Light-based Technologies (IYL 2015). Aware of the key role of Photonics in the economies and in the societies of the XXI century, the UIMP has decided to create the “**International School on light Sciences and Technologies (ISLIST)**”.

This school is envisioned to be a worldwide top International forum (every fourth week of June) on *Light Sciences and Technologies* in the framework of a “*special top university*” that is recognized as the “*university of universities*” and in a privileged environment “the Royal Magdalena Palace” in Santander, Cantabria, Spain. Each edition of this international school will have an intensification or main core in a specific application area and additional current hot topics. ***Light in communications and sensing*** is the core of this 2018 edition.

ISLIST has been conceived as a great opportunity to review, actualize and improve the knowledge of ***scientists, professionals and technicians***; to contribute to the education and to enhance the motivation of ***PhD students***; to offer an ideal frame for ***networking*** and also to contribute to the education of the **citizens**. It is also a great opportunity to ensure that **policymakers, entrepreneurs**, and other key “actors” will be aware of the problem-solving potential of Photonics.

Sixteen (16) **highly renowned** professors and researchers from the most prestigious worldwide institutions and, as well, presidents of the most reputed international Photonic Scientific Organizations will participate in this meeting.

The City Council of Santander will offer to ISLIST attendees a **Reception** at the Royal Palace of Magdalena. This Santander Happy Hour (with snacks and drinks) will be an optimum time for networking.

To be able to reach this ambitious program this International School of UIMP is supported by several sponsors: **Gobierno de Cantabria, Fundación ACS, the Optical Society (OSA), ENSA and Prysmian Group**.

It is also supported by several collaborators such as: the **Santander City Council, AMBAR Telecomunicaciones, B-Phot Brussels Photonic Team, OZ Optics, SPIE, INNOVA Scientific, Álava Ingenieros, ERZIA, Semicrol**, Spanish Optical Society (**SEDOPTICA**), **Real Sociedad Española de Física, Hotel Santemar** and the **Photonics Engineering Group** of the University of Cantabria.

Without these Sponsors and Collaborators, this top-quality school and over 30 International Student Grants (already allocated from over 15 different nationalities) would not have been possible. The UIMP, the direction of this event and the scientific community using Light are grateful with the generosity of all these Organizations and all the Invited Speakers. Thank you so much!



Goals

To actualize and improve the knowledge of *scientists, professionals and technicians*; to contribute to the education and to enhance the motivation of *PhD students*; to offer an ideal frame for *networking*. It is also a great opportunity to ensure that policymakers, politicians and common citizens become aware of the problem-solving potential of Photonics.

Overview

The event will take place from Monday (June 25, 2018) to Friday (June 29, 2018). The first part of the week will be focused on key subjects concerning Light in Communications, while the second part of the week will be focused on key subjects concerning Light in Sensing. As an important technology for communications and sensing, a special session on photonics crystals is programmed with the two inventors of the technology that, probably, will be the first time that both speakers are invited for the same session. It is planned that both researchers will be proposed as a joint candidature for the Princesa de Asturias 2018 award that is being promoted by this ISLIST director. Two round tables looking for Challenges on Optical Communications and Photonic sensing are also planned.

General Schedule

Time	Monday 25 th	Tuesday 26 th	Wednesday 27 th	Thursday 28 th	Friday 29 th
9:30		Prof. Sir John Pendry Inventor of the Metamaterials Imperial College London, UK	Prof. JM López Higuera Head, Photonic Engineering Group University of Cantabria, Spain	Prof. Hugo Thienpont Director of Brussels Photonics, Vrije University, Belgium	Photonic Crystal's Special Session Prof. Eli Yablonovitch Director, NSF Center for Energy Efficient Electronics Science Univ. of California, Berkeley, USA
10:15	Opening Remarks				
10:40	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:00	Opening talk Prof. Sir John Pendry Inventor of the Metamaterials Imperial College London, UK	Prof. Harald Haas Director, LIFI Research Development Centre, Scotland, UK	Dr. Nikolaus P. Schmitt Senior Researcher, Airbus Group Innovations Muenchen, Germany	Prof. David D. Sampson Vice-Provost, Research& Innov. University of Surrey, UK Head, OBEL, University of Western Australia.	Photonic Crystal's Special Session Prof. Philip Russell Director, Max Planck Institute for the Science of Light, Erlangen, Germany
12:10	Prof. Peter Andrekson Director FORCE, Chalmers University of Technology, Sweden	Dr. Joel Carpenter University of Queensland, Australia	Prof. Pavel Cheben Principal Researcher National Research Council of Canada	Prof. Joseba Zubía Head, POF Sensing Group, Univ. of the Basque Country Spain	12:30 Closing remarks, ISLIST2019 announcement and Diploma Delivery
13:30 15:00	Lunch	Lunch	Lunch	Lunch	
15:30	Dr. Peter Winzer Chair, Optical Transmission Systems and Networks Bell Labs, USA	Round Table I Optical communications challenges <i>Peter. Winzer</i> <i>Peter Andrekson</i> <i>José Capmany</i> <i>Harald Haas</i> <i>Eli Yablonovitch</i> Moderator: JM López-Higuera	Prof. Manuel López-Amo Head, Optical Communications Group of Public University of Navarre, Spain	Round Table II Photonic sensing challenges <i>Hugo Thienpont</i> <i>David Sampson</i> <i>N.P. Schmitt</i> <i>Pavel Cheben</i> Moderator: JM López-Higuera	
16:40	Prof. José Capmany Head, Photonics Research Labs Technical University of Valencia, Spain		Prof. Miguel González Head, Photonics Engineering Group of Univ. of Alcalá de Henares, Spain		
17:55			Family Photo Santander City Council Reception		

PROGRAM

Monday, 25

Why Light matters for Communications and Sensing?

10:15 h

Opening Ceremony

10:40 h / **Break**

11:00 h / Opening Invited Talk

The Science of Invisibility Cloaks and Metamaterials

Prof. Sir John Pendry

Inventor of the Metamaterials. The Blackett Laboratory, Imperial College London, UK.

12:10 h / Invited Talk

Optical fiber communication: Challenges and opportunities

Prof. Peter Andrekson

Director FORCE, Laboratory at the Microtechnology and Nanoscience Department Chalmers University of Technology, Sweden

13:30-15:00 h / **Lunch Time**

Afternoon: **Light in Communications**

15:30 h / Invited Talk

Breaking the Optical Fiber Shannon Limit Through Full Control of the Optical Field

Prof. Peter Winzer

Chair Optical Transmission Systems and Networks Bell-Nokia Labs, USA

16:40 h / Invited Talk

Advances in Analog and RF Photonics

Prof. José Capmany

Head Photonics Research Labs at iTEAM Institute, Technical University of Valencia, Spain

Tuesday, 26

Morning: **Light in the nanoscale and Communications**

9:30 h / Invited Keynote

Controlling Light on the Nanoscale

Prof. Sir John Pendry

Inventor of the Metamaterials. The Blackett Laboratory, Imperial College London, UK.

10:40 h / Break

11:00 h / Invited Talk

LiFi-High Speed Wireless Networking using Nano-Metre Waves

Prof. Harald Haas

Director of LIFI Research Development Centre, Scotland, UK

12:10 h / Invited Talk

Spatial mode manipulation in communications and imaging

Dr. Joel Carpenter

School of Information Technology, University of Queensland, Australia.

13:30-15:00 h / Lunch Time

Afternoon: **Challenges on Communications**

15:30 h- 17:45 / Round Table I

Light on Communications: Challenges to face

Prof. José Capmany, **Head** Photonics Research Labs at iTEAM Institute, Technical University of Valencia, Spain

Challenges on Analog and RF Communications

Dr. Peter Winzer, **Director** Optical Transmission Systems and Networks Research Dept, Bell-Nokia Labs in Holmdel, USA

Challenges on Digital Communications

Prof. Peter Andrekson, **Director** FORCE, Chalmers University of Technology, Sweden.

Challenges on Fiber Nonlinearities and their use in mixed Photonic-Digital Systems

Prof. Harald Haas, **Director** of LIFI Research Development Centre, University of Edinburgh, Scotland, UK.

Challenges on LIFI Communications

Prof. Eli Yablonovitch, **Director** NSF Center for Energy Efficient Electronics Science, University of California, Berkeley, US.

Silicon Photonics and other forms of Optical Communications

Prof. JM López-Higuera, **Director** ISLiST, **Moderator**

Wednesday, 27

Morning: **Light in Silicon Photonics and Sensing**

9:30 h / Invited Talk

Smart Light based Sensors

Prof. JM López-Higuera

Head, Photonic Engineering Group of University of Cantabria, CIBER-BBN and IDIVAL, Spain.

10:40 h / Break

11:00 h / Invited Talk

Forward-looking LIDAR for aircraft: research results, lessons learned and trends

Dr. Nikolaus P. Schmitt

Past Senior Expert, Optronics Systems, Airbus Group Innovations, Muenchen, Germany.

12:10 h / Invited Talk

Advanced Silicon Photonics for Communications and Sensing

Prof. Pavel Cheben

Principal Researcher, National Research Council of Canada, Canada.

13:30 -15:00h / Lunch Time

Afternoon: **Light on fiber based Sensors**

15:30 h / Invited Talk

Optical fiber Sensor Networks: State of the art and trends

Prof. Manuel López-Amo

Head, Optical Communications Group of the Public University of Navarre, Pamplona, Spain.

16:40 h / Invited Talk

Optical fiber Distributed Sensors

Prof. Miguel González Herráez

Head, Photonics Engineering Group of Univ. of Alcalá de Henares, Madrid, Spain

17:55 h ISLiST Family Photo

18:05 h / Special Event

Santander City Council Reception

The Santander City Council will offer to ISLiST attendees a special reception that, in addition, will be an optimum time to share experiences and promote networking.

Thursday, 28

Morning: **Light based sensors**

9:30 h / Invited keynote

Photonics as a key-enabling technology: From disruptive research to successful innovation with societal impact

Prof. Hugo Thienpont

Director of Brussels Photonics, Vrije University, Belgium

10:35 h / **Break**

11:00 h / Invited Talk

Biomedical optical sensors and imaging: opportunities for guided waves

Prof. David D. Sampson

Vice-Provost, Research&Innovation, University of Surrey, UK; **Head**, OBEL, University of Western Australia.

12:10 h / **POF Sensors for Aircraft Structural and Engine Health Monitoring**

Prof. Joseba Zubía

Head, POF based Sensors Group, University of the Basque country, Spain

13:30-15:00 h / **Lunch Time**

Afternoon: **Challenges in Sensing**

15:30h- 17:45 / Round Table II

Challenges in Sensing Using Light

Prof. Hugo Thienpont, Vice-Rector for Innovation and Industrial policy, Vrije Universiteit Brussel, Brussels Belgium

General Challenges on Photonic Sensing to face on XXI century

Prof. Pavel Cheben, Principal R. Officer, National, Research Council (NRC), 1200 Montreal Rd., Ottawa, Canada

Challenges on Silicon Photonics for Communications and Sensing

Dr. Nikolaus P. Schmitt, Past Senior Researcher of Airbus Group Innovations, Muenchen, Germany

Challenges to face on Photonic sensing for the aerospace

Prof. David Sampson, Vice-Provost, Research & Innovation, University of Surrey, UK

Challenges on Biomedical Optical Sensors

Prof. JM López-Higuera, Director ISLiST, **Moderator**



Friday, 29

Special Session on Photonic Crystals

9:30 /Invited keynote I

The Birth of the Photonic Bandgap Concept and its Application in Technology, as well as in Nature

Prof. Eli Yablonovitch

Inventor of Photonic Crystal

Director, NSF Center for Energy Efficient Electronics Science, University of California, Berkeley, USA

10:40 h / Break

11:00 /Invited keynote II

The birth of photonic crystal fibre and its many scientific and technical applications

Prof. Philip Russell

Inventor of Photonic Crystal Fibers

Director, Max Planck Institute for the Science of Light, Erlangen, Germany. 2015 OSA President.

12:30 h

Closing Remarks, Announcement of ISLiST 2019 and Diploma Delivery

The UIMP official diploma will be delivery to each attendee by very well-known ISLiST Professors.

Abstracts/Bios

Highly renowned Professionals and Scientists from the most prestigious Organizations will highlight the importance of Photonics for a new world. Key trends and challenges will be identified in several areas of paramount importance.

Invited Speaker

Talk

Biography



Prof. Sir John Pendry

**Inventor of the
Metamaterials
Dan David Prize 2016**

**Imperial College London,
UK**

June 25, 2018/11:00 h

Opening Invited Talk

The Science of Invisibility Cloaks and Metamaterials

Electromagnetism encompasses much of modern technology. Its influence rests on our ability to deploy materials that can control the component electric and magnetic fields.

A new class of materials has created some extraordinary possibilities such as a negative refractive index, and lenses whose resolution is limited only by the precision with which we can manufacture them.

Cloaks have been designed and built that hide objects within them, but remain completely invisible to external observers. The new materials, named metamaterials, have properties determined as much by their internal physical structure as by their chemical composition and the radical new properties to which they give access promise to transform our ability to control much of the electromagnetic spectrum.

Sir John Pendry is worldwide recognized by his outstanding contribution to physics through seminal research in surface science, photonics and metamaterials.

John Pendry has the rare distinction among scientists of having established a completely new and unexpected area of research – metamaterials. The electromagnetic properties of materials – such as electrical conductivity – were standardly thought to depend upon the properties of the materials of which they are composed. In the case of metamaterials, however, their electromagnetic properties depend upon their structure: this has had a tremendous impact, enabling the identification of new properties not found in nature.

Pendry's perfect lens makes use of such a novel property – negative refraction – and is a remarkable example of the revolutionary nature of metamaterials. Negative refraction had been postulated in the 1960s by Victor Veselago, but no examples of the phenomenon had been found in nature. Using the metamaterials proposed by Pendry, David Smith's team, then at the University of California, San Diego, combined magnetic and electrical metamaterials to construct the first negatively refracting metamaterial. Moreover, Pendry discovered that a lens manufactured from negatively refracting material would circumvent Abbe's diffraction limit to spatial resolution, which has stood for more than a century. In this way he gave the first prescription for a perfect lens – one whose resolution is limited only by the perfection of manufacture.

More recently, in collaboration with a team of scientists at Duke University, he has deployed transformation optics to develop a cloak of invisibility that has attracted worldwide public interest. The cloak can hide objects from electromagnetic fields, and a version of this design working at radar frequencies has now been implemented experimentally.

He has received numerous honours including the IOP's Isaac Newton Medal in 2013, the Kavli Prize of the Norwegian Academy of Science and Letters in 2014 and the Dan David Prize in 2016. In 2004 he was honoured with a knighthood for his services to science.



Prof. Peter Andrekson

Director

FORCE (Fiber Optic Communications Research Centre)

Photonics Laboratory at the Microtechnology and Nanoscience Department Chalmers University of Technology, Sweden

June 25 / 12:10 h
Invited Talk

June 26 /15:30
Round Table I

Optical fiber communication: Challenges and opportunities

The data throughput and transmission reach in optical fiber systems is primarily limited by noise and by the transmission fiber nonlinearity (Kerr effect). The former is fundamental, while the latter is largely deterministic and is possible to mitigate at least partially. A key element in any long-haul optical transmission system is the optical amplifier. The Erbium-doped fiber amplifier is widely used to compensate for the transmission losses, but suffers from a quantum-limited noise figure of 3 dB as do all conventional optical amplifiers.

In this talk, I will review the current limitations, challenges, and opportunities in optical communication. One highlight includes the use of phase-sensitive amplifiers. These amplifiers are not only capable to amplify light with lowest possible noise figure (0 dB quantum limit, 1 dB reported) but can also simultaneously mitigate transmission fiber nonlinearity impairments, a result of the coherent superposition of the signal and idler waves in the amplifier.

Prof. Andrekson received his Ph.D. from Chalmers in 1988. After three years with Bell Laboratories, USA, he returned to Chalmers where he is a full professor. He was Director of Research at Cenix Inc. and with Lehigh University in Allentown, USA, during 2000-2004. He co-founded Picosolve Inc. in 2004, now part of EXFO. He has authored about five-hundred publications in the area of optical communications, including four tutorials at OFC. He served on the Board of Governors for the IEEE Photonics Society and on several program committees, most recently as program chair of the European Conference on Optical Communication in 2017. He also served as expert evaluator of Nobel prizes in physics and held an ERC advanced grant (2012-2017) on phase-sensitive optical amplifiers.

Andrekson is a Fellow of the OSA and the IEEE, and a member of the Royal Swedish Academy of Engineering Sciences.



Dr. Peter Winzer

Chair

Optical Transmission Systems and Networks Bell Labs, USA

Editor-in-Chief

IEEE/OSA Journal of Lightwave Technology, JLT

June 25, 2018 /15:30 h
Invited talk

June 26 /15:30
Round Table I

Breaking the Optical Fiber Shannon Limit Through Full Control of the Optical Field

Over the past decade, optical transmission systems have been closely approaching the nonlinear Shannon limit of conventional telecommunications fiber, which, unless resolved through completely new methods, threatens to soon result in an optical network "capacity crunch," with repercussions throughout our information-centric society.

New possibilities in ultra-fast digital electronic signal processing, coupled with our increasing abilities to digitally electronically control the full optical field across all its physical dimensions, including its spatial mode content, allow not only for new ways of optical communications but open up a new era in optical instrumentation far beyond telecom.

Peter J. Winzer Peter J. Winzer received his Ph.D. from TU Vienna, Austria. Supported by ESA, he investigated space-borne Doppler lidar and laser communications. At Bell Labs, where he heads Optical Transmission Research, he contributed to many high-speed transmission records. He pioneered spatial multiplexing and multiple-input-multiple-output to scale optical transport systems. He has widely published and patented and is actively involved with IEEE and OSA, currently the Editor-in-Chief of the IEEE/OSA Journal of Lightwave Technology. Program Chair of ECOC in 2009 and Program/General Chair of OFC in 2015/2017, he is a Highly Cited Researcher, Bell Labs Fellow, Fellow of IEEE and OSA, and Member of the US National Academy of Engineering. He has received multiple awards for his work, including the 2018 John Tyndall Award.



Prof. Jose Capmany

Head

Photonics Research Labs at iTEAM Institute, Technical University of Valencia, Spain

Editor-in-Chief

IEEE Journal of Selected Topics in Quantum Electronics

June 25 / 16:40 h
Invited talk

June 26 / 15:30
Round Table I

Advances in Analog and RF Photonics

RF or Analog Photonics is required for interfacing two information domains that operate under digital and analog information coding schemes respectively. 5G Fiber-wireless and the internet of Things are two representative examples that call for this technology in communication systems but there are many other which can benefit from this approach. In this talk I will address the basic principles behind Analog Photonics and review the recent advances, paying special attention to developments in integrated optic chips and Space Division Multiplexing Access techniques. The talk will also address the potential applications in emerging application fields, such as neurophotonics, quantum communications and programmable multifunctional photonic systems.

Prof. Capmany was born in Madrid, Spain. He received the Ingeniero de Telecomunicación degree from the Universidad Politécnica de Madrid (UPM) in 1987 and the Licenciado en Ciencias Físicas in 2009. He holds a PhD in Electrical Engineering from UPM and a PhD in Quantum Physics from the Universidad de Vigo. Since 1996 he is a Full Professor in optical communications, systems, and networks. From 2002 to 2016, he was the Director of the Institute of Telecommunications and Multimedia (iTEAM) at UPVa (www.iteam.upv.es). He is now the head of the Photonics Research Labs (www.prl.upv.es) at iTEAM.

His research activities and interests cover a wide range of subjects related to optical communications including microwave photonics (MWP), integrated optics, optical signal processing, fiber Bragg gratings, and more recently quantum cryptography and quantum information processing using photonics. He has published over 520 papers in international refereed journals and conferences and has been a member of the Technical Program Committees of the European Conference on Optical Communications (ECOC), the Optical Fiber Conference (OFC), the Integrated Optics and Optical Communications Conference (IOOC), CLEO Europe, and the Optoelectronics and Communications Conference (OECC). Professor Capmany is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE), the Optical Society of America (OSA) and the Institution of Electrical Engineers (IEE). He is also a founder and chief innovation officer of the spin-off company VLC Photonics (www.vlcp Photonics.com) dedicated to the design of photonic integrated circuits and EPHHOX (www.ephhoX.com) dedicated to MWP instrumentation.

Professor Capmany is the 2012 King James I Prize Laureate on novel technologies, the highest scientific distinction in Spain, for his outstanding contributions to the field of microwave photonics. In 2016, he was awarded an ERC Advanced Grant to develop on-chip universal microwave photonics processors. He is currently the Editor-in-Chief of the IEEE Journal of Selected Topics in Quantum Electronics and the Action Chair of COST A 16220 European network on High Performance Integrated Microwave Photonics (www.euimwp.eu).



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June 25-29, 2018, Santander, Spain



**Prof. Sir John
Pendry**

**Inventor of the
Metamaterials
Dan David Prize 2016**

**Imperial College London,
UK**

June 26, 2018/9:30 h

Invited Keynote Talk

Controlling Light on the Nanoscale

Our intuitive understanding of light has its foundation in the ray approximation and is intimately connected with our vision: as far as our eyes are concerned light behaves like a stream of particles. Here we look inside the wavelength and study the properties of plasmonic structures with dimensions of just a few nanometres: a tenth or even a hundredth of the wavelength of visible light, where the ray picture fails utterly. In this talk we show how the new concept of transformation optics that manipulates electric and magnetic field lines rather than rays can provide an equally intuitive understanding of sub wavelength phenomena and at the same time be an exact description at the level of Maxwell's equations. The concepts are applied to a number of plasmonic structures

Sir John Pendry is worldwide recognized by his outstanding contribution to physics through seminal research in surface science, photonics and metamaterials and through service to the Institute.

John Pendry is a leading UK physicist of international renown. He has the rare distinction among scientists of having established a completely new and unexpected area of research – metamaterials. The electromagnetic properties of materials – such as electrical conductivity – were standardly thought to depend upon the properties of the materials of which they are composed. In the case of metamaterials, however, their electromagnetic properties depend upon their structure: this has had a tremendous impact, enabling the identification of new properties not found in nature.

Pendry's perfect lens makes use of such a novel property – negative refraction – and is a remarkable example of the revolutionary nature of metamaterials. Negative refraction had been postulated in the 1960s by Victor Veselago, but no examples of the phenomenon had been found in nature. Using the metamaterials proposed by Pendry, David Smith's team, then at the University of California, San Diego, combined magnetic and electrical metamaterials to construct the first negatively refracting metamaterial. Moreover, Pendry discovered that a lens manufactured from negatively refracting material would circumvent Abbe's diffraction limit to spatial resolution, which has stood for more than a century. In this way he gave the first prescription for a perfect lens – one whose resolution is limited only by the perfection of manufacture.

More recently, in collaboration with a team of scientists at Duke University, he has deployed transformation optics to develop a cloak of invisibility that has attracted worldwide public interest. The cloak can hide objects from electromagnetic fields, and a version of this design working at radar frequencies has now been implemented experimentally.

Pendry has also made a full contribution to the wider scientific community through roles at the IOP and other organisations. Between 2007 and 2011 he served on the Institute's Council as vice-president for publishing and as chair of the IOP Publishing board. At the Royal Society, he was elected a fellow in 1984, was a member of council over 1992-4 and was editor of Royal Society Proceedings A between 1996 and 2002. He also served as chair of the physics sub-panel of the 2008 UK Research Assessment Exercise from 2005. He has received numerous honours including the IOP's Isaac Newton Medal in 2013, the Kavli Prize of the Norwegian Academy of Science and Letters in 2014 and the Dan David Prize in 2016. In 2004 he was honoured with a knighthood for his services to science.



Prof. Harald Haas

Director

LIFI
Research Development Centre,
Scotland, UK

June 26 / 11:00 h
Invited talk

LiFi - High Speed Wireless Networking using Nano-Metre Waves

The visible light spectrum is 1000 times larger than the entire radio frequency spectrum of 300 GHz, and this simple fact provides the motivation to use the visible light spectrum to augment RF cellular communications. We will set the scene by motivating the need for new wireless spectrum. Then we will go on to provide a general background to the subject of optical wireless communications. We will discuss the relationship between VLC and LiFi, introducing the major advantages of VLC and LiFi and discuss existing challenges. Recent key advancements in physical layer techniques that led to transmission speeds greater than 10 Gbps will be discussed. Moving on, we introduce channel modelling techniques, and show how this technology can be used to create fully-fledged cellular networks achieving orders of magnitude improvements of area spectral efficiency compared to current technologies. The challenges that arise from moving from a static point-to-point visible light link to a LiFi network that is capable of serving hundreds of mobile and fixed nodes will be discussed. An overview of recent standardization activities will be provided – primarily focusing on the new IEEE 80211 LC (light communication) Study Group activities. Lastly, we will moot commercialization challenges of this disruptive technology.

Prof. Haas received the PhD degree from the University of Edinburgh in 2001. He currently holds the Chair of Mobile Communications at the University of Edinburgh, and is co-founder and Chief Scientific Officer of pureLiFi Ltd as well as the Director of the LiFi Research and Development Center at the University of Edinburgh. His main research interests are in optical wireless communications, hybrid optical wireless and RF communications, spatial modulation, and interference coordination in wireless networks. He first introduced and coined spatial modulation and LiFi. LiFi was listed among the 50 best inventions in TIME Magazine 2011.



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International School on Light
Sciences and Technologies ISLiST
June 25-29, 2018, Santander, Spain



Dr. Joel Carpenter

School of Information
Technology;
University of Queensland,
Australia

June 26 / 12:10 h
Invited Talk

Spatial mode manipulation in communications and imaging

The ability to analyse and control light's spatial properties is a fundamental requirement in many disciplines throughout optical physics. Imaging is an obvious example, where how light occupies space is measured directly to reveal details of the object being imaged. However other applications such as telecommunications and the field of Space Division Multiplexing are also increasingly looking to the spatial properties of light as a means of increasing information capacity.

In this talk, research will be presented on measuring and manipulating light's spatial properties. This includes the creation of 'pre-scattered' light states which can propagate through a scattering media, only to form a desired image on the other side. As well as work on the creation of devices capable of splitting a light beam up into the spatial modes it is composed of, a functionality for the spatial domain that is analogous to how a dispersive prism splits white light up into its constituent colours.

Dr. Joel Carpenter received his PhD in Electrical Engineering from the University of Cambridge, UK in 2012 for his work on Mode Division Multiplexing in optical telecommunications before working as a postdoctoral researcher at The University of Sydney, Australia. He is now a Lecturer at his alma mater, The University of Queensland. His research focuses on the measurement and manipulation of fiber modes using spatial light modulators and computational holography.

June 26 / 15:30-17:45 h, Round Table I:

Light on Communications: Challenges to face

Prof. José Capmany, Head Photonics Research Labs at ITEAM Institute, Technical University of Valencia, Spain

Challenges on Analog and RF Communications

Dr. Peter Winzer, Director Optical Transmission Systems and Networks Research Dept, Bell-Nokia Labs in Holmdel, USA

Challenges on Digital Communications

Prof. Peter Andrekson, Director FORCE, Chalmers University of Technology, Sweden. (tentative)

Challenges on Fiber Nonlinearities and their use in mixed Photonic-Digital Systems

Prof. Harald Haas, Director of LIFI Research Development Centre, University of Edinburgh, Scotland, UK.

Challenges on LIFI Communications

Prof. Eli Yablonovitch, Director NSF Center for Energy Efficient Electronics Science, University of California, Berkeley, USA

Challenges on Photonic Crystals for communication and sensing

Prof. JM López-Higuera, Director ISLiST, Moderator



**Prof. José Miguel
López-Higuera**

Head

Photonic Engineering
Group of University of
Cantabria, CIBER-BBN and
IDIVAL, Spain

June 27 / 9:30 h

Invited Talk

Round Tables I & II
moderator

Smart Light based Sensors

Photonics is considered a Key Enabling Technology (KET) or an Essential Technology for the development of Europe, USA and others main nations around the world. Photonic Sensing is understood as any sensing approach that employs light sciences and technologies and it is becoming an area with very substantial expectations of annual growths and with strong socio-economic impacts in the first decades of this XXI century.

In the talk, after a mention of what it must be understood, in wide sense, as the general and comprehensive concept of Sensing Using Light and also Smart Light Sensors, SLS, we will do a "flight" over several significant cases of their use on real structures inside a wide number of sector application. The trends for the near future will be also addressed and discussed.

Prof. López-Higuera is the founder and head of the Photonics Engineering Group of the University of Cantabria, CIBER-BBN of Institute of Health Carlos III and IDIVAL of Hospital Universitario Marqués de Valdecilla, Spain. He is a Member of a wide set of international Committees of Conferences, R&D Institutions, and Companies in the area of photonic sensing. His work is focused on optical sensor systems and instrumentations for any sector application. He has worked in a wide range of R&D&i projects, acting in more than 90 of them as manager.

He has contributed with more than 700 research publications including 20 patents closely related to optical and fiber techniques for sensors and instrumentations. He has worked as an editor and co-author of four R&D international books, as a co-editor of several conference proceedings and Journals and he has been the director of 17 PhD theses. He is co-founder of three technology-based companies.

Prof. López-Higuera is a Fellow of OSA, Fellow of SPIE, Senior of IEEE and a Member of the Royal Academy of Medicine of Cantabria.



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June 25-29, 2018, Santander, Spain



**Dr. Nikolaus P.
Schmitt**

**Senior Expert
Optronics Systems**

Airbus Group Innovations
Muenchen, Germany

June 27 / 11:00 h
Invited Talk

June 29/ 15:30
Round Table II

**Forward-looking LIDAR for aircraft:
research results, lessons learned and
trends**

Measurement of air data is vital to control an aircraft. Since decades this is done using fluid flow pressure sensors. Recent optical air data sensors (OADS) based on backscatter Laser Doppler LIDAR provide a unique technology to precisely measure the air flow vector even remotely outside the aircraft boundary layer. Beside air flow, laser backscatter further allows for remote measurement of air temperature and density as well. Replacing conventional sensors, the required measurement distances for such OADS LIDAR are typically in the order of meters, measuring just outside of the aerodynamic boundary layer or at the edge thereof. But LIDAR can provide more than that:

The optical remote sensing of airflow at larger distances ahead of an aircraft enables additional future new functionalities such as real-time feed-forward of signals to the flight control, based on 3D measured air flow disturbances (e.g. turbulences, gusts) before the aircraft reaches them. In this new way of forward control, the impact of turbulences on the aircraft could be reduced in future with the help of LIDARs. Major LIDAR principles as well as results of LIDAR air data sensors on-board aircraft will be discussed.

Dr. Nikolaus P. SCHMITT has more than 30 years of experience in lasers and optronics for aerospace and defence. He studied physics and philosophy at Tuebingen and Muenchen and received a diploma and Dr. rer. nat. degree in Physics both from Ludwig-Maximilians-University Muenchen.

He mainly worked on diode pumped solid state lasers, MOEMS, LIDAR systems and optical communications (free space and fiber) for aeronautics, space and defence. He is Senior Expert Optronics Systems at Airbus (formerly EADS) and chairman of the AIRBUS Research Technology Group on Optics/Optronics.

Dr. Schmitt is a reviewer for several funding bodies, scientific magazines, member of conference technical committees and steering boards.



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Prof. Pavel Cheben

Principle Researcher
National Research Council of Canada

June 27/ 12:10 h
Invited Talk

June 29/ 15:30
Round Table II

Advanced Silicon Photonics for Communications and Sensing

By locally engineering the refractive index of silicon by forming a pattern of holes at the subwavelength scale, it is possible to manipulate the flow of light in silicon photonic integrated circuits. This powerful concept has resulted in a plethora of advanced integrated photonic devices with unprecedented performance for applications in optical interconnects, telecommunications and sensing.

Subwavelength engineered silicon waveguide structures are likely to become the key building blocks for the next generation of integrated photonic circuits. We will present an overview of this surging field, including the fundamental principles, recent advances and applications.

Prof. Pavel Cheben is a Principal Research Officer at the National Research Council of Canada. He is also an Honorary Professor at University of Malaga, Adjunct Professor at Carleton University, McMaster University, University of Ottawa, and University of Zilina. He was one of the lead scientists starting up Optenia Inc. and developed the first commercial echelle-grating wavelength multiplexer. Prof. Cheben's research focusses on silicon photonics, subwavelength metamaterial nanophotonic structures, and on-chip spectrometers and biosensors. He has co-authored more than 400 journal and conference papers, has 30 patent applications and over 180 invited presentations. He is the most published scientist of the National Research Council of Canada 2010-17. He is an elected Fellow of the European Optical Society, Fellow of the Optical Society of America and Fellow of the Institute of Physics.



Prof. Manuel López-Amo

Head of the
Optical Communications Group of Public University of Navarre, Pamplona, Spain

June 27 /15:30 h
Invited talk

Optical fiber Sensor Networks: State of the art and trends

One of the main goals in fiber optic sensor technology is to multiplex together a high number of sensors in the same network, in order to reduce the costs by sharing expensive terminal equipment, developing a system that includes multiple measuring points.

The presentation will deal with multiplexing networks for point and quasi- distributed optical fiber sensors (avoiding distributed sensors) and explain what they are and why they are unique; this would include a brief historical perspective on their development. It would then deepen into the principles of these systems and define broad categories based on the measurand and the underlying physics.

Different kind of multiplexing networks for optical fiber sensors would be described and compared here, including networks that use optical amplification, and also lasing multiplexing systems. State of the art in multiplexed sensor networks would be also presented, including robust and remote ultralong networks. Finally, selected application examples of such networks will be described.

Prof. López-Amo is a professor in photonics at Universidad Pública de Navarra (Spain). He participated in the first demonstrations of optical amplifiers in optical signal processing and in optical fiber sensing. Also in optical fiber tapers for sensing and in the experimental demonstration of multiwavelength random fiber lasers using Rayleigh backscattering. His research is focused nowadays in optical fiber lasers and remote sensing using optical fiber networks. He has been the leader of more than 60 research projects and he has coauthored more than 300 works in international refereed journals and conferences. He is a member of the technical committees of the International Conference on fiber optic sensors (OFS) and the European Workshop on optical fiber sensors (EWOFS), among others.



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Prof. Miguel González Herráez

Head
of Photonics
Engineering Group of
Univ. of Alcalá de
Henares, Madrid, Spain

June 27 / 16:40 h
Invited Talk

Optical fiber Distributed Sensors

Distributed optical fibre sensors are increasingly used in civil engineering, for the monitoring of large critical infrastructure such as large pipelines, dams, bridges, tunnels, etc. In these sensors, the entire length of the optical fibre is used as sensing element, and a large number of physical variables (strain, temperature, vibration, pressure, etc.) can be monitored at each point along the fibre. This way, a single optical fibre can replace thousands of point sensors, the same fibre acting as transducer and transmission element. The fact that the optical fibre is the sensing element also offers additional advantages, since the fibre is inherently immune to electromagnetic noise; it is also small and lightweight, and stands well humidity and corrosion, which makes it an appealing option for very harsh environments. This talk will review the basic principles and limitations of these sensors, and will provide a roadmap to the future developments in this area.

Miguel Gonzalez-Herraez (Senior Member, OSA) is currently a Full Professor in Photonics at the University of Alcala (Spain). His research interests are primarily related to distributed optical fiber sensing systems. He is the author or co-author of >110 journal papers and >200 conference contributions. He has received several important recognitions to his basic research activity and technology transfer contributions in this area, including the European Research Council Starting Grant, the “Miguel Catalan” Prize given by the Regional Government of Madrid, and the “Agustin de Betancourt” prize of the Spanish Royal Academy of Engineering.



Prof. Hugo Thienpont

Chair
Department of Applied
Physics and Photonics

Director of Brussels
Photonics, Vrije
University, Belgium

June 28 / 9:30 h
Invited Keynote

June 28 / 15:30
Round Table II

Photonics as a key-enabling technology: From disruptive research to successful innovation with societal impact

In recent years Europe has heavily and successfully invested in disruptive fundamental and applied photonics research, but it is still struggling to efficiently and effectively deploy these frontier results in the industrial innovation eco-system. In this presentation we identify the major roadblocks that need to be overcome to bridge this innovation valley-of-death, we give best practices on how to transition fundamental research results to industrial innovation with European companies, and illustrate the approach with a variety of success stories in different industry sectors with special emphasis on food sensing.

Prof. Thienpont chairs the Applied Physics and Photonics Department and is director of its photonics research group B-PHOT (Brussels Photonics), which he built over the years and which today counts more than 60 scientists, engineers, and administrative and technical staff. Since 2012 he is also VUB Vice-Rector for Innovation and Industrial policy. Hugo authored more than 880 WOS cited papers. His research work was internationally recognized with several awards.

He also coordinates several large-scale research and networking projects at the European level and manages photonics related industrial projects.

Hugo Thienpont is recognized for his contributions to photonics in education and appreciated by his peers for his service to the photonics community. He is Vice-President of the European Technology Platform “Photonics21” and has played an active role in this high-level advisory board for optics and photonics to the European Commission since its foundation in 2005.



Prof. David D. Sampson

Vice-Provost, Research and Innovation
University of Surrey,
Guildford, UK

Head, OBEL, University of Western Australia,
Australia

June 28 / 11:00 h
Invited Talk

June 28 / 15:30
Round Table II

Biomedical optical sensors and imaging: opportunities for guided waves

Biomedical optical fibre sensors, which encompasses imaging devices, continue to make great inroads into medical and biological applications and remain a topic of intense research. In medical applications that require in situ measurement, optical sensing via hypodermic needles, catheters and endoscopes provides access to the huge diversity of optical methods at locations that are otherwise inaccessible to optics. Elsewhere in bioscience and technology, the advantages of sensing via optical fibres are not so clear cut, but profound examples and new opportunities exist. In this talk, we provide brief perspective on the past, necessary to provide current context, but mainly focus on contemporary technologies and applications. We describe prospects, issues and opportunities for contemporary biomedical fibre-optic sensors research.

Professor David Sampson is the Vice-Provost, Research & Innovation, at the University of Surrey, Guildford, UK and Professor of Electrical, Electronic & Computer Engineering at the University of Western Australia David's main research interests are in the science and applications of light in medicine and biology - biomedical optics or biophotonics. He is an authority in optical coherence tomography, and its translation in medicine. David is active in the global optics & photonics community, serving as Director of the SPIE – The International Society for Optics & Photonics (2017-2019), and is a fellow of the optical societies, SPIE and OSA, and the electrical engineering society, IEEE. He serves on various society committees and editorial boards.



Prof. Joseba Zubía Zaballa

Head, POF based sensors Group
University of the Basque Country
Spain

June 28 / 12:10 h
Invited Talk

POF Sensors for Aircraft Structural and Engine Health Monitoring

Aircraft structures and engines require periodic, scheduled inspection and maintenance operations. Such operations are time-consuming, labor intensive and a cost factor to the operations of commercial and defense aircraft fleets. Structural health monitoring (SHM) is a cost-effective approach to meet operational requirements, and to reduce maintenance costs in aircrafts. Polymer fiber optic sensor (PFOS) technology is a mature technology that provides advantages over traditional sensors, and can be used to monitor physical parameters not only of wing surfaces and fuselage sections but also of the engines themselves.

Prof. Zubía received the M.Sc. degree in solid-state physics and the Ph.D. degree in physics from the University of the Basque Country, Bilbao, Spain, in 1988 and 1993, respectively. He is currently a Full Professor with the Department of Communications Engineering, School of Engineering of Bilbao, University of the Basque Country. Dr. Zubía received a Special Award for the Best Thesis in 1995 and the Euskoiker Prize in 2010. Since 1993 he is the leader of the Applied Physics group, which main field of interest is plastic optical fibers and applications.

June 28/ 15:30-17:45 h, **Round Table II:**

Challenges in Sensing Using Light

Prof. Hugo Thienpont, Vice-Rector Innovation & Industrial Policy, Vrije University, Belgium

General Challenges on Photonic Sensing to face on XXI century

Prof. Pavel Cheben, Principal R. Officer, National, Research Council (NRC), 1200 Montreal Rd., Ottawa, Canada

Challenges on Silicon Photonics for Communications and Sensing

Dr. Nikolaus P. Schmitt, Past Senior Researcher of Airbus Group Innovations, Muenchen, Germany

challenges to face on photonic sensing for the for aerospace

Prof. D. Sampson, Vice-Provost, Research & Innovation, University of Surrey, UK; **Head OBEL**, University of Western Australia.

Challenges on Biomedical Optical Sensors

Prof. JM López-Higuera, Director ISLiST, Moderator

Special Session on Photonic Crystal



**Prof. Eli
Yablonovitch**

**Inventor of
Photonic Crystals**

Director

NSF Center for Energy
Efficient Electronics
Science, University of
California, Berkeley, USA

June 26/ 15:30 h

Round Table

June 29 / 9:30 h

Invited Keynote

The Birth of the Photonic Bandgap Concept and its Application in Technology, as well as in Nature.

Photonic crystals are also part of everyday technological life in opto-electronic telecommunication devices that provide us with internet, cloud storage, and email. But photonic crystals have also been identified in Nature, in the coloration of peacocks, parrots, chameleons, butterflies and many other species. In spite of its broad applicability, the original motivation of photonic crystals was to create a "bandgap" in which the spontaneous emission of light would be inhibited. Conversely, the opposite is now possible. The "optical antenna" can accelerate spontaneous emission. Over 100 years after the radio antenna, we finally have tiny "optical antennas" which can act on molecules and quantum dots. Employing optical antennas, spontaneous light emission can become faster than stimulated emission.

Prof. Yablonovitch introduced the idea that strained semiconductor lasers could have superior performance due to reduced valence band (hole) effective mass. With almost every human interaction with the internet, optical telecommunication occurs by strained semiconductor lasers.

He is regarded as a Father of the Photonic BandGap concept, and he coined the term "Photonic Crystal". The geometrical structure of the first experimentally realized Photonic bandgap, is sometimes called "Yablonovite".

In his photovoltaic research, Yablonovitch introduced the $4(n^2)$ ("Yablonovitch Limit") light-trapping factor that is in worldwide use, for almost all commercial solar panels.

His mantra that "a great solar cell also needs to be a great LED", is the basis of the world record solar cells: single-junction 28.8% efficiency; dual-junction 31.5%; quadruple-junction 38.8% efficiency; all at 1 sun.



Prof. Philip Russell

Inventor of
Photonic Crystal Fibers

2015 OSA President

Director

Max Planck Institute for
the Science of Light,
Erlangen, Germany

June 29 / 11:00 h

Invited Keynote

The birth of photonic crystal fibre and its many scientific and technical applications

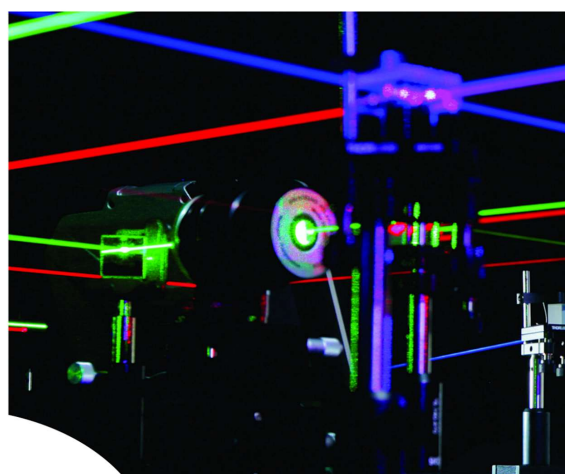
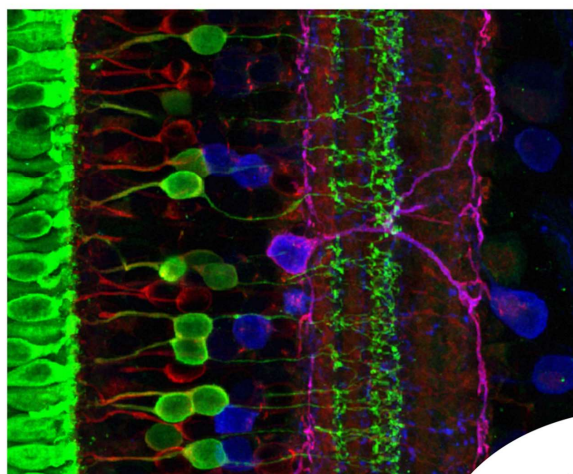
The idea for a new kind of optical glass fibre—photonic crystal fibre (PCF)—first emerged in 1991 [Science 299, 358 (2003)]. The aim was to realise a fibre with a two-dimensional periodic array of microscopic features (typically hollow channels) running along its entire length. This would allow light to be tightly confined within a tiny solid or, more remarkably, hollow core while providing control of dispersion. The first working PCF left the drawing tower in 1995 and now, more than two decades later and after many breakthroughs, PCF has already moved into real-world applications. For example, solid-core PCFs are being used commercially to convert infrared pulses into white light supercontinua 10 million times brighter than an arc lamp, and hollow core PCF filled with gases is underpinning a range of extremely bright sources of tunable deep and vacuum ultraviolet light, driven by ultrashort pulses of infrared light.

Prof. Russell is a founding Director of the Max-Planck Institute for the Science of Light and Krupp Professor of experimental physics at the University of Erlangen-Nuremberg. He obtained his D.Phil. (1979) degree at the University of Oxford. His interests currently focus on light-matter interactions in microstructured and photonic crystal fibres. He is a Fellow of the Royal Society and the Optical Society (OSA) and the recipient of a number of awards including the 2000 OSA Joseph Fraunhofer Award/Robert M. Burley Prize, the 2005 Thomas Young Prize of the Institute of Physics (London), the 2005 Körber Prize for European Science, the 2013 EPS Prize for Research into the Science of Light, the 2014 Berthold Leibinger Zukunftspreis, the 2015 IEEE Photonics Award and the 2018 Rank Prize for Optoelectronics. He was OSA's President in 2015, the International Year of Light. In June 2016 he received an honorary doctorate from the Universidad Internacional Menéndez Pelayo in Santander, Spain.



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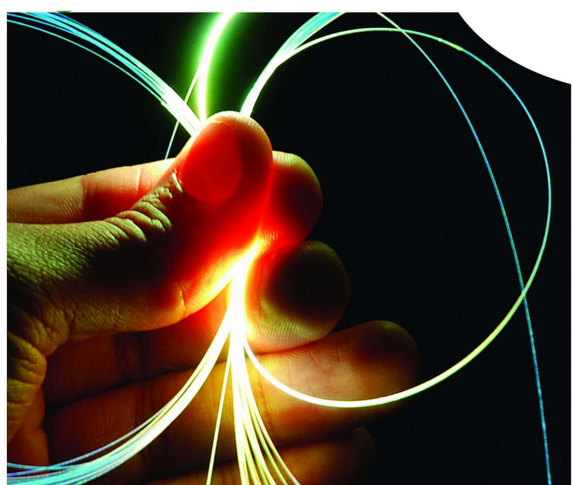
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June 25 / 11:00 h / **Prof. Sir John Pendry**

The Science of the Invisibility Cloaks and Metamaterials

NOTES:



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June 25 / 12:10h / **Prof. Peter Andrekson**

Optical fiber communication: Challenges and opportunities

NOTES:



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June 25 / 15:30 h / **Dr. Peter Winzer**

Breaking the Optical Fiber Shannon Limit Through Full Control of the Optical Field

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June 25 / 16:40 h / **Prof. José Capmany**

Advances in Analog and RF Photonics

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June 26 / 9:30 h / **Prof. Sir John Pendry**

Controlling Light in the Nanoscale

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June 26 / 11:00 h / **Prof. Harald Haas**

LiFi - High Speed Wireless Networking using Nano-Metre Waves

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June 21/ 12:10 h / **Dr. Joel Carpenter**

Spatial mode manipulation in communications and imaging

NOTES:



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June 26/15:30 h / Round Table I:

Light on Communications: Challenges to face



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June 27 / 9:30 h / **Prof. JM López-Higuera**

Smart Light based Sensors

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June 27 / 11:00 h / **Dr. Nikolaus P. Schmitt**

Forward-looking LIDAR for aircraft: research results, lessons learned and trends

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June 27/ 12:10 h / **Prof. Pavel Cheben**

Silicon Photonics for Communications and Sensing

NOTES:



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June 27 / 15:30 h / **Prof. Manuel López-Amo**

Optical fiber sensor Networks

NOTES:



June 27 / 16:40 h / **Prof. Miguel González Herráez**

Optical fiber Distributed Sensors

NOTES:



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June 28 /9:30 h / **Prof. Hugo Thienpont**

Photonics as a key-enabling technology: From disruptive research to successful innovation with societal impact

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June 28 / 11:00 h / **Prof. David Sampson**

Biomedical Optical Sensors and imaging: opportunities for guided waves

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June 28 / 12:10 h / **Prof. Joseba Zubía**

POF Sensors for Aircraft Structural and Engine Health Monitoring

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June 28/15:30 h / Round Table II:

Light on Sensing: Challenges to face





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June 29 / 9:30h / **Prof. Eli Yablonovitch**

The Birth of the Photonic Bandgap Concept and its Application in Technology, as well as in Nature

NOTES:



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June 29 / 11:00 h / **Prof. Philip Russell**

The birth of photonic crystal fibre and its many scientific and technical applications

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