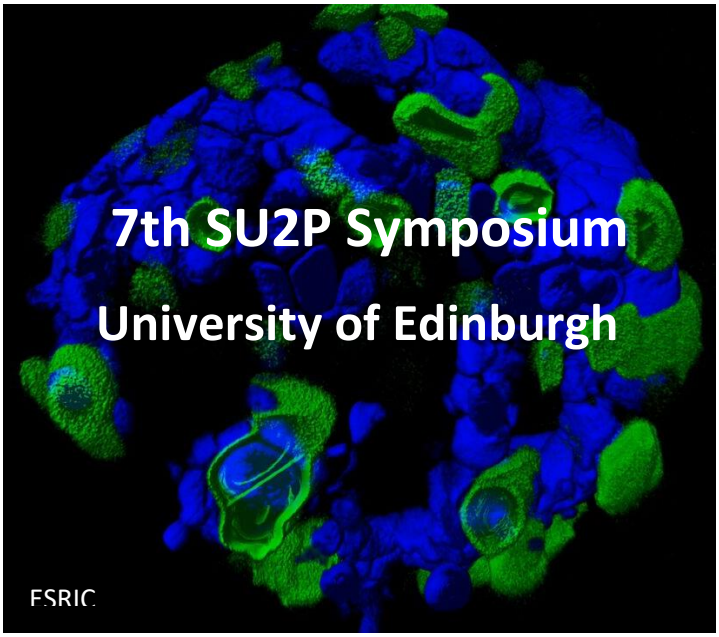
SU2P *[ĕs ū tōō pē]: an innovative bridging project connecting Scottish and Stanford Universities; an industry-academic interaction; entrepreneurial activity in photonics*




# Monday 4th April and Tuesday 5th April 2016

## South Hall Complex Pollok Halls Edinburgh

# Symposium Programme

**Day 1 Monday April 4th 2016**

| | | |
|---|---|---|
| 09.00 | Tea/Coffee and registration | Exhibition and posters – Kirkland Suite |
| 09.30 | Welcome Address | **Ian Underwood**<br>**Prof Sir Timothy O' Shea - Principal of Edinburgh University** |
| 09.45 | Keynote | **Jim Harris -Stanford Photonics Research Centre**<br>*"Nanophotonics and the Quest to Accelerate Electrons with Light"* |
| 10.30 | Keynote | **Mark Bradley - University of Edinburgh**<br>*"In vivo optical imaging – from glass to man"* |
| 11.15 | Tea/coffee | exhibition, posters |
| 11.45 | **Theme Session 1 SSL & NLO**<br>Chair Alan Kemp | **Henry Bookey - Fraunhofer UK**<br>*" Offshore wind LIDAR – laser system development and measurement challenges"*<br>**Daniel Esser- Heriot Watt University**<br>*"Laser device technology for laser-based manufacturing"* |
| 12.50 | **Poster presentations** | One Slide Poster Pitches |
| 13.20 | Lunch | exhibition, poster session |
| 14.15 | **Industry Session**<br>Chair Carol Scullion | **Tom Baer – Stanford Photonics Research Centre**<br>*"The National Photonics Initiative and more…."*<br>**Stuart Parks – Medical Devices Unit GGHB**<br>*"A Practical Framework for NHS MedTech Innovation"* |
| 15.15 | Refreshments | exhibition, posters, image collection |
| 15.45 | **Theme Session 2 Health New Photonics Advances for Healthcare**<br>Chair Rory Duncan | **Chris Contag - Stanford Photonics Research Centre**<br>*"Micro-optical devices for early detection of cancer"*<br>**Lars Michael Larsen- Copenhagen University**<br>**Robert Thomson - Heriot-Watt University**<br>*"Endoscopic sensing of pH in the distal lung"*<br>**Alan Serrels - University of Edinburgh**<br>*"Intravital imaging of cancer phenotypes and protein function."* |
| 17.30 | session close | |
| 18.30 | Pre Dinner | **Informal music & refreshment in the Kirkland Suite – SPONSORED BY THORLABS** |
| 19.30 | Symposium Banquet | **Colin Prior** ; Keynote and Judge for Image Competition |

**Day 2 Tuesday April 5th 2016**

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| 08.30 | Tea/coffee | exhibition and posters |
| 09.00 | Keynote | **Sheila Rowan - University of Glasgow**<br>*"Optics for future gravitational wave detectors"* |
| 09.30 | **Theme Session 3**<br>**Energy & Environment**<br>Chair Peter Skabara | **James Durrant - Imperial College London**<br>**Geoff Williams - Durham University**<br>*"Energy Efficient Lighting as part of an integrated system; the opportunities and challenges"*<br>**Roger Hiorns - Pau University** |
| 11.15 | refreshments | exhibition, posters |
| 11.45 | **Special Session**<br>**Data Centres & Communication**<br>Chair Allister Ferguson | **Dimitra Simeonidou**<br>**Bardia Pezeshki Kaiam Corporation**<br>*"Hybrid optical integration using a MEMS-aligned process"*<br>**Joseph Kahn - Stanford Photonics Research Centre**<br>"*Capacity Limits of Spatially Multiplexed Free-Space Communication"* |
| 13.30 | Lunch | Exhibition and posters |
| 14.30 | **Theme Session 4**<br>**ICT**<br>Chair Marc Sorel | **David Richardson - University of Southampton**<br>*"Emerging fibre technology for optical communications"*<br>**William Whelan-Curtin- University of St Andrews**<br>*"Photonic Crystal Lasers for Data Communications"*<br>**Richard Hogg - University of Glasgow**<br>**Lucia Caspani - Heriot Watt University**<br>"*Multiplexed quantum states on chip: towards integrated quantum frequency combs"* |
| 16.15 | Thanks and Closing Remarks | Carol Scullion & Allister Ferguson |

## SU2P Industry Partners

The SU2P Industry Partnership Programme has a network of Industry Partners and we are delighted to welcome **Kaiam Corporation** to the SU2P Symposium as our new industry partners for 2016.

# Exhibitors in Kirkland Suite

Exhibiting SU2P Industrial Partners

**M Squared Lasers**

**Coherent**

Exhibiting Industry

**AMS**

**Hamamatsu**

**Laser Quantum**

**Avantes**

**Lesker**

**Elliot Scientific**

**Chromacity**

**Technology Scotland**

**Thorlabs are not exhibiting this year but have provided sponsorship for the musical entertainment for the banquet**

## Posters will be located in the South Hall

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| Shuailong Zhang | University of Glasgow | Assembling and manipulating metallic beads using optoelectronic tweezers |
| Alan Paterson | University of Strathclyde | Intracavity micromirrors for tuning the spectral and temporal output characteristics of solid-state lasers |
| Ganga Chinna Rao Devarapu | University of St Andrews | Photonic Crystal Cavities in Polysilicon Substrate |
| Giuseppe Cantarella | University of Strathclyde | Tunable Efficiency FWM Generation and Dual TE/TM Pump Filtering on a Single Silicon |

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| | | Chip |
| Margaret Normand | University of Edinburgh | Tunable liquid crystal lasers for biomedical sensing |
| Dimitars Jevtics | University of Strathclyde | Transfer Printing of Semiconductor Nanowire Lasers for the Next Generation of Nanophotonic Device Fabrication |
| Frances Goff | University of St Andrews | The role of Willin in neuronal differentiation: using SIM microscopy to examine interplay between the actin cytoskeleton and oncogenic TAZ |
| Oguzhan Kara | Heriot-Watt University | Mid-Infrared Dual Comb Spectroscopy with Independent Asynchronous Optical Parametric Oscillators |
| Stuart Ingleby | University of Strathclyde | Sensitivity enhancement for optically-pumped magnetometry in unshielded applications |
| Steven Bramsiepe | University of Glasgow | A Practical MEMS Gravimeter |
| Yogeshwar Kale | University of Strathclyde | Towards Rotation Sensing as a Quantum Technology |
| Yueyang Zhai | University of Strathclyde | Maximum contrast interferometry and coherence in Bose-Einstein condensates |
| Calum MacRae | University of Strathclyde | Optical magnetometry using nitrogen-vacancy centres |
| Saydulla Persheyev | University of St Andrews | Novel silicon photonic crystal based external-cavity hybrid lasers |
| Georgia Anastasiadi | Heriot-Watt University | Machined optical fibres for on-chip optical trapping |
| Zhang Teng | University of Glasgow | On misalignment of the balanced |

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| | | homodyne detector |
| Andrew MacKellar | University of Strathclyde | Single-shot, phase-insensitive readout of an atom interferometer |
| Adam Fleming | University of St Andrews | Exploiting the optothermal nonlinearity of silica aerogel for light diffusion control |
| Aline Heyerick | University of St Andrews | Direct Writing of Nanoplasmonic Structures using EBID |
| Aruna Ivanturi | University of Edinburgh | High Efficiency Perovskite Solar Cells based on Novel Triarylamine - based Hole Transport Materials |
| Rachel Offer | University of Strathclyde | Cavity-enhanced frequency up-conversion in rubidium vapour |
| Zeno Tornasi | University of Glasgow | Research towards low optical and mechanical loss silicon optics for cryogenic gravitational wave detectors |
| Oliver Burrow | University of Strathclyde | Gratings for quantum technologies |
| David Vocke | Heriot-Watt University | Nonlocal fluids made of light |
| Rachel Elvin | University of Strathclyde | Towards Ultra-Cold Portable Atomic Clocks |
| Boniface Antwi | University of Strathclyde | Investigation of the efficient conversion of photon energy to electricity by newly synthesized well-ordered low band gap semiconducting organic molecules |
| Roman Spesyvtsev | University of St Andrews | Temporal focussing microscopy for holographic optical trapping and neural imaging |

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| Hannah Niland | University of Edinburgh | Development of Fluorescence Methods for the Detection of Residual Protein on Surgical Instruments |
| Fiona Quinlan-Pluck | University of Edinburgh | An investigation of photophysical tools to quantify and improve the quality of the eggshell cuticle |
| Holly Fleming | University of Edinburgh | Encapsulated SERS Nanosensors – Fibre-based pH Sensing |

# Pollock Halls of Residence

## The University of Edinburgh

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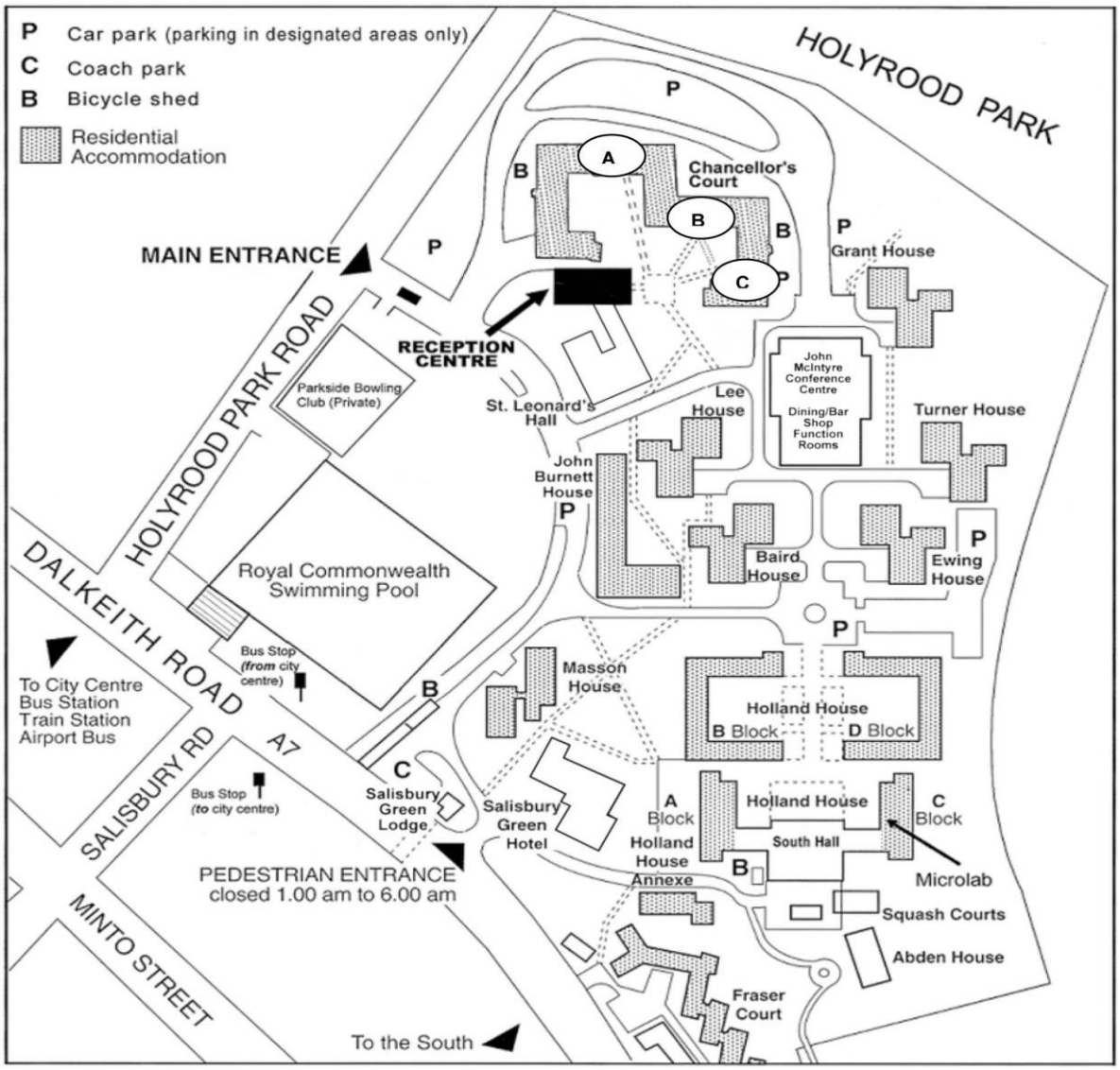


### Useful phone numbers

Visit Scotland: 0131 332 2433
Central Taxis: 0131 229 4466
Lothian Buses info: 0131 555 6363
First Edinburgh bus info: 08708 72 72 71
Rail enquiries: 08457 48 49 50

Edinburgh Airport: 0131 333 1000
British Airways (reservations): 08708 50 98 50
British Airways (flight info): 0870 55 111 55
British Midland Airways: 0870 60 70 555
KLM UK: 08705 074 074

### Wireless Access

There is free Wi-Fi in the venue. This is through the keysurf network. Guests will be asked to login by providing an email address (and phone number if on a phone). This will then allow access to the Wi-Fi.

## SPEAKER CVs AND ABSTRACTS

**Mark Bradley - University of Edinburgh**

**In vivo optical imaging – from glass to man**

A formidable challenge in modern respiratory healthcare is the accurate and timely diagnosis of lung infection and inflammation. The EPSRC Interdisciplinary Research Collaboration (IRC) 'Proteus' seeks to address this challenge by developing an optical fibre based healthcare technology platform that combines physiological sensing with multiplexed optical molecular imaging. This technology will enable *in situ* measurements in the distal lung to assess tissue function in health as well as generate and characterise unique signatures of pulmonary disease.

Professor Mark Bradley is director of Proteus an Interdisciplinary Research Collaboration supported by major investment from the EPSRC (£11.3M) and the three partner universities (£3M). Inter-disciplinarity is at the heart of Proteus - linking together disciplines such as optical physics, chemistry, biology and engineering to name but a few. The driver is clinical pull and need – working with clinical scientists on a day-to-day basis to understand the limitations of current technologies and developing the tools they need.

Mark has been elected to fellowships of both the Royal Society of Chemistry and Royal Edinburgh, and has awarded a number of prizes such as the 2015 Royal Society of Chemistry Tilden Prize. He has published over 300 peer-reviewed papers, filed some 20 patents and is co-founder of multiple spinout companies including Ilika Technologies (IPO on AIMS 2010) and of Edinburgh Molecular Imaging (2014).

**Henry Bookey - Fraunhofer UK**

**Offshore wind LIDAR – laser system development and measurement challenges**

Wind LIDAR, a technique that measures the Doppler shift of light scattered back from aerosols carried by the wind, is a powerful technique that is becoming accepted in the wind industry for applications spanning anenergy project's life cycle. The ever-increasing size of turbine rotors has placed new demands upon wind LIDAR. This talk will explore the challenges of taking such laser based sensor systems from the laser laboratory to the field including limitations imposed by nonlinear optics. We will also look ahead to the next generation of wind LIDAR exploiting the latest breakthroughs in integrated optics.

Dr Bookey joined the Fraunhofer Centre for Applied Photonics in 2013. His recent research interests include novel optical waveguides and glass fibres for sensing applications and he was awarded a Royal Society of Edinburgh Personal Research Fellowship in this area. His

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| | integrated optics work includes multi-core fibre, chalcogenide waveguides and directly written waveguide devices. He is a co-founder of Heriot Watt spin out company Optoscribe Ltd. He also led a Proof of Concept project developing a miniaturised sensor interrogator system. More recently he has been working on wind LIDAR systems and the role of photonics in the energy sector. |
|  | **Christopher Contag – Stanford University**<br><br>**Micro-optical devices for early detection of cancer**<br>Current technologies for the detection of cancer lack the sensitivity for early detection at times when therapy would be most effective, and cannot detect minimal residual disease that persists after conventional therapies. Therefore, it will be necessary to develop devices for multiplexed molecular characterization of cancer and visualization of small numbers of cancer initiating cells. Imaging and sensing will need to move from detection limits of 1 cm to 1 mm, or even 100 µm diameter masses, and new technologies with this sensitivity need to be developed. Optical imaging has the sensitivity for this level of detection and new instruments based on micro-optical designs can be used to reach in the body to reveal microanatomic and molecular detail that are indicators of early disease.<br><br>Dr. Contag is a Professor in the Departments of Pediatrics, Bioengineering, Radiology and Microbiology & Immunology at Stanford University, and a member of the BioX Faculty for interdisciplinary sciences, and the Immunology Faculty. Dr. Contag received his Ph.D. in Microbiology from the University of Minnesota in 1988. He was a postdoctoral fellow at Stanford University from 1990-1994, and was appointed to the faculty in Pediatrics at Stanford in 1995. Dr. Contag is the Associate Chief of the Division of Neonatal and Developmental Medicine, and co-director of the Molecular Imaging Program at Stanford (MIPS) and the Child Health Research Institute. |
|  | **Alan Serrels – University of Edinburgh**<br><br>**Intravital imaging of cancer phenotypes and protein function.**<br><br>Confocal and multiphoton imaging in the mouse has become a powerful tool in pre-clinical cancer research, and has yielded new insights into cancer cell behaviour, the tumour microenvironment, and the molecular mechanisms driving the pathogenesis of cancer. We have taken advantage of emerging technologies to custom build a multi-modal microscope combining two-photon fluorescence with CARS and SRS, and show that this enables detailed in niche imaging of cancer and the complex tumour environment without the need for extensive labelling. Furthermore, we show that SRS enables imaging of anti-cancer drugs in cells, highlighting the potential of this technology for cancer imaging and drug studies<br><br>Following graduation from the University of Glasgow, Alan worked in |

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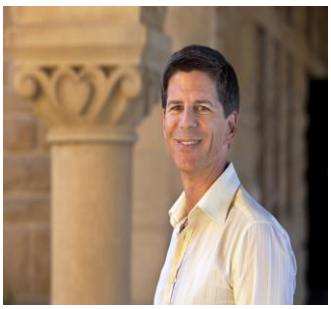
| | Pharma for 3½ years. He then moved to the Beatson Institute for Cancer Research in Glasgow where he completed his PhD. A key aspect of this was the development of techniques for the application of advanced microscopy in the in vivo tumour environment.<br>Alan joined the University of Edinburgh Cancer Research Centre (ECRC) in January 2008, where he has established a state-of-the-art intra-vital cancer imaging platform and setup the ECRC Advanced Imaging Facility.<br><br>Today his research interests are two-fold:<br>1. Development and application of advanced microscopy techniques to *in vivo* cancer research.<br>Understanding the role of Focal Adhesion Kinase (FAK) in controlling anti-tumour immunity. |
|  | **Bardia Pezeshki – Kaiam Corporation**<br><br>**Hybrid optical integration using a MEMS-aligned process**<br><br>Highest performance and lowest cost optical functions are best obtained in the shortest time by using proven and mature building blocks. We show the use of a MEMS breadboard to interconnect silica-based PLCs, III-V lasers, and silicon photonics for a variety of functions.<br><br>Bardia Pezeshki is currently the CEO of Kaiam, a company focused on advanced multi-lane transceivers for data center interconnects. Prior to Kaiam, Bardia was the CTO and VP of engineering of Santur Corp, developing tunable lasers for metro and long haul fiber optics. Before starting these two companies, Bardia was managing the development of novel optical devices at SDL Inc and IBM's T.J. Watson Research center. He received his PhD from Stanford University with a thesis on vertical cavity optical devices. |
|  | **Joseph M. Kahn – Stanford University SPRC**<br><br>**Capacity Limits of Spatially Multiplexed Free-Space Communication**<br><br>Orbital angular momentum, a physical property of electromagnetic waves, has been proposed as a new degree of freedom for multiplexing information in optical fibres and free-space optical links, generating significant interest in the scientific community. However, the capacity of orbital angular momentum multiplexing has not been established or compared to other multiplexing techniques. Here, we show that orbital angular momentum multiplexing is not an optimal technique for realizing the capacity limits of free-space communication channels, and is outperformed by conventional line-of-sight multi-input multi-output transmission and by conventional spatial-mode multiplexing.<br><br>Joseph M. Kahn is a Professor of Electrical Engineering at Stanford University. His research addresses communication and imaging |

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| | through optical fibres, including modulation, detection, signal processing and spatial multiplexing. He received A.B. and Ph.D. degrees in Physics from U.C. Berkeley in 1981 and 1986. From 1987-1990, he was at AT&T Bell Laboratories, Crawford Hill Laboratory, in Holmdel, NJ. He was on the Electrical Engineering faculty at U.C. Berkeley from 1990-2003. In 2000, he co-founded StrataLight Communications, which was acquired by Opnext, Inc. in 2009. He received the National Science Foundation Presidential Young Investigator Award in 1991 and is a Fellow of the IEEE. |
|  | **David Richardson Southampton University**<br><br>**Emerging fibre technology for optical communications**<br><br>Researchers are within a factor of 2 or so from realizing the maximum practical transmission capacity of conventional single mode fibre transmission technology in the laboratory and it is therefore necessary to consider new technological approaches offering the potential for more cost effective scaling of network capacity than simply installing more and more conventional single mode fibre systems in parallel. In this talk I shall review emerging fibre technologies offering significant potential for both enhanced per-fibre capacity and reduced costs per transmitted bit – the primary enabler being the application of space division multiplexing.<br><br>**David Richardson** obtained his B.Sc. and PhD in fundamental physics from Sussex University U.K. in 1985 and 1989 respectively. He joined the Optoelectronics Research Centre (ORC) at Southampton University in 1989 and was awarded a Royal Society University Fellowship in 1991 in recognition of his pioneering work on short pulsed fibre lasers. Professor Richardson has been Deputy Director of the ORC with responsibility for optical fibre and laser related research since 2000. He has published more than 1000 research papers and produced more than 30 patents during his time at Southampton. He was one of the co-founders of SPI Lasers Ltd an ORC spin-off venture acquired by the Trumpf Group in 2008, which now employs >300 people within the UK. Professor Richardson is a Fellow of the IEEE, OSA and IET and was made a Fellow of the Royal Academy of Engineering in 2009. He received a Royal Society Wolfson Research Merit Award in 2013 for his optical communications research. |
|  | **Liam O'Faolain - University of St Andrews**<br><br>**Photonic Crystal Lasers for Data-communications**<br><br>Energy efficient Wavelength Division Multiplexing (WDM) is the key to satisfying the future bandwidth requirements of datacentres. As the silicon photonics platform is regarded the only technology able to meet the required power and cost efficiency levels, the development of silicon photonics compatible narrow linewidth lasers is now crucial. |

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| | We discuss the requirements for such laser systems and report the experimental demonstration of an external-cavity hybrid lasers consisting of a III-V Semiconductor Optical Amplifier and Photonic Crystal (PhC) based resonant reflector on SOI that provides the excellent wavelength control required for such applications.<br><br>Dr. Liam O'Faolain received a BSc degree in Physics (Honours) from University College Cork (Ireland) in 2001, and a PhD degree on microstructured modelocked semiconductor lasers from the University of St Andrews (UK) in 2005. He is one of the leading authorities on disorder and loss in Photonic Crystals and has designed and realised the world's best slowlight waveguides to date. His group uses photonic crystal cavities to enhanced light matter interactions for applications in energy efficient datacommunications. He has published 90 journal papers and his H-Index is 32. |
|  | **Dr Lucia Caspani – Heriot-Watt University**<br><br>**Multiplexed quantum states on chip: towards integrated quantum frequency combs**<br><br>Single and entangled photons form the building block for quantum cryptography and computing applications. Recently, many efforts have been dedicated to the generation of such states of light in integrated platforms, with the aim to further boost the diffusion of quantum based applications out of the lab. We addressed this issue by proposing novel devices and schemes for the generation of single and entangled photons that can directly benefit from the multiplexing of information over several wavelengths, compatibly with the fibre network infrastructure. In particular, we recently achieved the generation of a frequency comb of time-bin entangled photon on chip.<br><br>Lucia Caspani received her Bachelor (2003), Master (2006) and PhD Degree (2010) in Physics from Insubria University (Como, Italy). She theoretically investigated the spatiotemporal structure of entanglement in second order nonlinear media. From April 2011 to May 2014 Dr Caspani has been a postdoctoral fellow at INRS-EMT (Canada), where she carried out research activities mainly related to the generation of non-classical states of light in high-index doped silica glass integrated structures. Since July 2014 she is a Marie Curie IIF Research Fellow at Heriot-Watt University, performing research on the generation of entangled photon triplets and low-permittivity media nonlinearity. |
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