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Welcome

In the beginning and all the way through 2015 there was light. UNESCO proclaimed 2015 as the International Year of Light and light-based technologies (IYL), in recognition of the importance of the contribution of lightwave technologies to sustainable development and providing pivotal solutions to global challenges in energy, education, agriculture and health. Photonics is now on the political agenda in the USA, Europe and many developed and developing countries. The IYL gave people working in photonics a remarkable opportunity to reflect on what they are doing and why. Photonics makes a difference by opening up new significant academic vistas, by contributing to innovation, new products and economy, and by directly improving people’s lives. Photonics is capable of changing places and lives. Photonics can make important contributions to the activities of the Global Challenges Research Fund set by the UK Government to support cutting-edge research that addresses the challenges faced by developing countries.

We learned in 2015 about the various (and sometimes amazing) impacts of photonics on communities around the world, what telecom based on light technologies means to the GDP of some African countries, how it can help many people who still cannot read and learn after sunset, how to generate light from surrounding waste in emergencies, and other fascinating applications.

This was a tremendous chance to look at photonics on a global scale and better recognise that how big we are is defined by the scale of the problems we are interested in and the problems we are able to solve. In 2015, AIPt organised an IYL workshop with an impressive list of speakers and world leading experts in the field. Moreover, we organised Lightfest, which in one day brought more than twelve thousand people to Birmingham central library, including a multitude of enthusiastic kids with shining and wide open eyes, looking at whom we knew with apodictic certainty that this event was a great success (of course, it takes a couple of years to become an overnight success – only entropy comes easy). It is likely that we changed some lives and hopefully for the better. The purpose of science is to generate new knowledge. Sometimes we pay less attention to another important goal - passing already accumulated information on to new generations and transforming their lives. Creating new knowledge and transferring it in a structured form through time, somehow, can locally and within certain limits, withstand an increase of entropy (use the term “entropy” and you can never lose a debate), von Neumann told Shannon - because no one really knows what “entropy” is. This gives science a captivating philosophical angle.

As somebody said: “Years ago I discovered the meaning of life, but forgot to write it down”. The Lightfest reminded us about the pleasure and satisfaction of sharing passion for science with others and the rediscovery of the true meaning of educational and outreach activities in the life of the research institute. I am sure that the spirit of the IYL will live well beyond 2015.

In 2016 we celebrate the 25th anniversary of the Photonics Research Group (and the 50th anniversary of Aston University, and (some of us, who like to talk about information) the 100th anniversary of the birth of Claude Shannon, what a year). We have a history we are proud of. Our research students and postdoctoral researchers work in industry around the world, JLR, Bell Labs, CISCO, BAE Systems, BT, Ericsson, Alcatel-Lucent-Nokia, Tyco Communications, MIT Lincoln laboratory, even Nature Photonics to mention a few, and became professors, research and industrial leaders in different universities, companies and countries. Our research is well balanced between blue sky fundamental science and down to earth practically important industrial projects.

25 years ago Ian Bennion and Nick Doran transformed this place in Birmingham. The structure they created – the Photonics Research Group, predecessor of the Aston Institute of Photonic Technologies has endured and is capable of expansion, continuing to change this place. Building structures is also against the course of increasing entropy (not sure by now what is wrong with increasing entropy and why we should be happy when we delay its growth while expanding ourselves). This report summarises information about our activities and progress in 2015. Aston University committed £7.5m to develop a brand new laboratory space for AIPt. This gives us transcendent opportunities for further growth and new global initiatives. It is in our strategic plans to increase in coming years the number of research MSc and PhD students and establish a structured MSc by Research program and postgraduate school. We have been awarded in the past five years 24 Marie Skłodowska-Curie Fellowships and in 2016 AIPt won a multimillion EU COFUND project MULTIPLY to run a worldwide international program of MSC Fellowships in photonics, making our international visibility global. We aspire to establish new and strengthen existing long-term industrial partnerships with global companies linking research collaborations and educational programs. We are 25 this year. Our history and proud heritage earned us a formidable reputation and we have a challenge to live up to our reputation and enhance it through writing a new history of Birmingham and photonics science and technology, transforming places and lives.
AiPT Mission
The mission of the Aston Institute of Photonic Technologies is through research integrated with education to generate and advance knowledge and innovation in photonics and translate the scientific breakthroughs into technology making industrial, economic and societal impact.

AiPT Vision
Through growth and consolidation of the current leading position and expansion of our capability, by 2020 the Aston Institute of Photonic Technologies will be a centre of excellence in photonics, with global international visibility, reputation as a trailblazer in research and innovation, strong industrial links and knowledge transfer, several strategic industrial partnerships, and will be a beacon of photonic learning and public outreach activities, ranked among the top academic photonic centres in the world.

AiPT Aims
Based on our vision and mission, we aim to expand our research, translational and outreach activities through attracting world leading academics, talented young researchers and students, the development of world class laboratory facilities commensurate with AiPT growth, building a financial operational model, establishing the Aston Photonics Education Centre and joining efforts with the other groups at the School of Engineering and Applied Science, Aston Business School and School of Life & Health Sciences in creating the Aston Impact Acceleration Centre.

The Aston Institute of Photonic Technologies will be guided by the four interconnected strategic goals: research, post-graduate education, translational activities and public outreach.

25th Anniversary

Aston Institute of Photonics Technologies was founded as a research group in September 1991 by Ian Bennion and Nick Doran. It was inaugurated as the Institute in March 2012. Now 25 years later much has happened but the group they started then, now led by Sergei Turitsyn, has grown to something way beyond even their most extreme dreams.

We are extremely proud of having such a long history of innovation and research. On 16 of September 2016 we are going to have a celebration to which we invite all our graduates and staff who worked there during all these years.
People

Academic staff

Our passionate and enthusiastic people make us different. The following people made 2015 a successful year for AiPT.

Prof. Sergei Turitsyn, Director of AiPT

Prof. Andrew Ellis, AiPT Deputy Director

Prof. Lin Zhang, AiPT Deputy Director, Head of Electrical, Electronic and Power Engineering

Prof. Keith Blow, Head of Adaptive Communications Research Group

Prof. David Webb, AiPT Deputy Director

Prof. Nick Doran, Professor of Photonics

Prof. Edik U. Rafailov, Professor in Optoelectronics

Dr. Natalia Bazieva, Lecturer

Dr. Sonia Boscolo, Senior Lecturer

Dr. Wladek Forysiak, Senior Lecturer in Applied Physics

Prof. Misha Sumetsky, Professor of Photonics

Dr. Vladek Forystek, Senior Lecturer in Applied Physics
Dr. Paul Harper, Director of Undergraduate Electronic Engineering Programmes

Dr. Vladimir Mezentsev, Senior Lecturer

Dr. Alex Rozhin, Senior Lecturer in Nanotechnology

Dr. Kate Sugden Reader, Placements Tutor

Dr. Elena Turitsyna, Lecturer in Electronic Engineering, outreach activities coordinator

Dr. John Williams, Reader

Dr. Sergey Sergeyev, Senior Research Fellow

Dr. Stylianos Sygletos, APT Fellow

Dr. Xuewen Shu, APT Fellow

Dr. Haitao Ye, Associated member of APT

Dr. Kaiming Zhou, APT Fellow

Dr. Maria Chernysheva (joined in 2015)

Dr. Dmitry Churkin

Dr. Artemiy Dmitriev (joined in 2015)

Dr. Mykhaylo Dubov

Dr. Vladislav Dvoyrin (joined in 2015)

Dr. Atalla El-Taheer

Mr. Simmon Fabbri

Dr. Farsheed Farjady

Dr. Ksenia Fedorova

Dr. Filipe Ferreira

Dr. Elias Giacoumids

Dr. Neil T. Gordon

Dr. Andrey Gorodetsky

Dr. Biqiang Jiang

Dr. Vladimir Kalashnikov

Dr. Lukasz Krzczanowicz (joined in 2015)

Dr. Sergey Kulinich

Dr. Daniel Lee

Dr. Graham Lee

Dr. Jianfeng Li

Dr. Karina Litvinova (joined in 2015)

Dr. Yury Loika

Dr. Petro Lutsyk (joined in 2015)

Dr. Naoise MacSuibhne

Dr. Amos Martinez (joined in 2015)
Dr. Mary McCarthy
Dr. Chengbo Mou
Dr. Stanislav Kolpakov Nikitin
Dr. Vladimir Osipov
Dr. Junsong Peng
Dr. Andreas Perentos
Dr. Ian Phillips
Dr. Yaroslav Pylepskiy
Dr. Lida Sadeghioon (joined in 2015)
Dr. Sergei Sokolovsky
Dr. Maria Sorokina
Dr. Marc Stephens
Dr. Srikanth Sugavanam
Dr. Qichen Sun
Dr. Nikita Tarasov
Dr. Ilya Titkov
Dr. Christos P Tsukrekos (joined in 2015)
Dr. Zhijun Yan
Dr. Wei Zhang
Dr. Junxi Zhang
Dr. Zuxing Zhang
Dr. Mohd Zamani Bin Zulkifli (joined in 2015)

Research Students
Mr. Mohammed Al'Araimi
Mr. Mohammad Al-Khateeb
Mrs. Raz Arif
Mr. Abdulyezir Ayomipo Badmos
Mr. Md Asif Iqbal
Mr. Adenowo Gbadedebo
Ms. Sandra Donohoe

Mr. Vladimir Gordienko
Mr. Huseyin Karakuzu
Mr. Morteza Kamalian Kopae
Mr. Hani Kbash (joined in 2015)
Mr. Son Thai Le
Mr. Teerawat Piromjiptong (joined in 2015)
Mr. Auro Michele Perego
Mr. Andreas Pospori
Mr. Zhongyuan Sun
Mr. Mingming Tan
Mr. Nikita Tarasov
Mr. Changle Wang
Mr. Amit Yadav
Ms. Tingting Zhang
Mr. Michal Zubel
Mr. Modestas Zulonas
Mr. Ilya Rafailov (joined in 2015)

Marie Sklodowska-Curie Fellows
Dr. Sergey Kulinich
Dr. Jianfeng Li
Dr. Naoise MacSullbane
Dr. Carlos Marques
Dr. Junsong Peng
Dr. Qichen Sun
Dr. Junxi Zhang
Dr. Zuxing Zhang
Dr. Christian Sanchez Costa
Dr. Filipe Ferreira
Dr. Biqiang Jiang
Dr. Petro Lutsyk
Dr. Amos Martinez
Dr. Mohd Zamani Bin Zulkifli

Visiting Researchers in AiPT in 2015
Prof. Valentin Freilikher, Bar-Ilan University, Israel
Prof. Yuri Kivshar, The Leverhulme Trust Visiting Professor, Australian National University, Australia
Prof. Alexander Rubenchik, Lawrence Livermore National Lab, USA
Prof. Gregory Falkovich, Weizmann Institute of Science, Israel
Prof. Evgeny M. Dianov, Fiber Optics Research Centre, RAS, Russia
Dr. Ilya Vatnik, IAE SB RAS, Russia

Professional staff
Mr. Andrew Abbot, Technician
Dr. Noreen Aftab, ICONIE Research Project Manager
Ms. Jolande Azzan, Business Development Manager
Dr. Christiane Doering-Saad, TRIPOD Project Manager
Ms. Tatiana Kilina, Research project manager
Ms. Olga Nemova, Business Development Manager
Mrs. Swaroopa Muchel Sudhakar, APT Technician

ASTON INSTITUTE OF PHOTONIC TECHNOLOGIES

Dr. Nikita Toropov,
ITMO University, Russia
Dr. Stanislav Derevyanko,
Weizmann Institute of Science, Israel
Dr. Alexander Turchin,
National Academy of Sciences, Ukraine,
Dr. Anand Srivastava,
Indian Institute of Technology Mandi, India
Dr. Guoju Yin,
Shenzhen University, China
Mr. Fangcheng Shun,
 Wuhan National Laboratory for Optoelectronics Huanzhong University of Science and Technology, China
Mr. Sergei Sukhanov,
 Saratov State University, Russia
Dr. Wladek Forysiak

Wladek has been associated with Aston University since 1992 when he became the first post-doctoral research fellow appointed by the then fledgling Photonics Research Group, which has since become AiPT. He has served Aston in multiple roles, as a lecturer/ reader in Electronic Engineering in the late nineties, and as a visiting researcher/reader and member of the UG/PG industrial steering committees during the 2000s. In 2012, he returned to Aston as a part-time Royal Society Industry Fellow, and was subsequently appointed a Senior Lecturer in Applied Physics in 2014. In 2015, Wladek began a new 5-year research project as an EPSRC Manufacturing Fellow, entitled “Towards Manufacturing of “Massive WDM” metro” (ToM3).

Wladek’s past research interests range from fundamental physics in nonlinear dynamics and chaos of three-level lasers, mode-locking, and ultra-short nonlinear pulse propagation effects, to engineering applications in soliton communications, WDM system design, dispersion management, and link and network planning. From 2000-2010 he worked for Marconi Communications and Ericsson Ltd as a Development Director and Network Modelling Manager, during which time he was responsible for the link design rules for the company’s WDM product portfolio. In this period, he also participated in UK DTI project “HiPNET” and EU FP7 project “APACHE”. From 2010-14 he was with Oclaro Technology Ltd as their Director of Technology and Systems, working in both UK R&D sites at Paignton and Caswell on various optical amplification and transmission technologies, including digital coherent pluggables using InP-based photonics.

Wladek’s EPSRC Manufacturing Fellowship is one of four awarded by EPSRC in 2014/15, as part of the 4th call for such fellowships, specifically aimed at researchers working in, or recently moved to academia from, industry. The objectives of ToM3 are to address future technical requirements for ultra-high capacity optical transport in metropolitan area networks, and to demonstrate the key building blocks of a “massive WDM” metro platform with a transmission bandwidth 3x greater than the current industry standard of 40nm, using compact and scalable “super-channel” transceivers and modular discrete Raman amplifiers. The fellowship grant is held in conjunction with Dr. Paul Harper, Prof. Nick Doran and Prof. Lin Zhang, and in the autumn of 2015 two post-doctoral fellows, Dr. Ian Phillips and Dr. Lukasz Krzczanowicz, joined the project as the associated experimental researchers.


Dr. Karina Litvinova

My Ph.D. degree in biophysics and physiology, received from the Institute for Biomedical Problems of Russian Academy of Sciences, Laboratory of Myology, provided a strong and diverse foundation in the field. The laboratory’s unique background in the area of muscle plasticity during gravitational unloading enabled me to work on projects with the Russian space agency (such as the BION M) and joint with colleagues from NASA and the ESA. Ultimately, my PhD training and my first post-doc position have given me many skills necessary to do gravitational biophysics that are also transferable to other areas of research.

During my postdoctoral work at Laboratory of Electrophysiology University of Bari, I was involved in a multidisciplinary project, granted by Italian Telethon, aimed at evaluating in vivo, ex vivo and in vitro pre-clinical efficacy of prompt-to-use drugs in an animal model of Duchene Muscular Dystrophy. As a recipient of a Telethon Research Fellowship, I was introduced to ex vivo recording of the isometric contractile properties of fast and slow twitch skeletal muscle of wild-type and dystrophic mdx mice and involved full-time in the experimental plans requiring these recordings. Along with notable results, I also became co-supervisor of a PhD-student, who successfully defended her PhD project.

I changed my research field in 2009, when I moved to the Medphys Laboratory of the Moscow Regional Research and Clinical Institute to work with in research and development of new diagnostic devices and equipment for the non-invasive fluorescence diagnostics. My work led to the development of new practical methods and diagnosis techniques, which greatly expanded the diagnostic capabilities of physicians. This resulted in my receiving three patents and producing various guidelines for medical practitioners. Thanks to MEDILASE and ABLADE research fellowships, I spent time at the University of Dundee and Ninewells Hospital, Dundee, UK.

Currently, our team, Dr. Sergei Sokolovski and PhD students Mr Ilya Rafailov and Mr Argyrios Tsatsakoulias, is young, but quite active. We have established strong contacts with the LHS and are using Laser Fluorescence Spectroscopy and Laser Doppler Flowmetry to develop optical sensors for diabetic foot. Following the development of methodologies, in collaboration with Prof. Asif Ahmed’s group, we present a technique that allows us to non-invasively assess the condition of animals during laboratory experiments and treatment. Our laser-based multifunctional diagnostics system was chosen to carry out non-invasive analysis of multiple parameters in the aim of improving preecclampsia diagnosis. In collaboration with Queen Elizabeth Hospital and Aston Medical School (Prof. Francesco Leyva), we are also developing biosensors for the diagnosis of cardiac muscle tissue. We are also conducting interesting pilot research with ophthalmologists at Aston University (Prof. James Wolffsohn) to explore the possibility of determining eye lens wearing individuals’ susceptibility to “dry eye” and other potential conditions. In collaboration with Professor Dion Morton from Institute of Cancer and Genomic Sciences and Dr. Roger Kockelbergh, University Hospitals of Leicester NHS Trust, we pursue previous research in the diagnosis and treatment of cancer.

Key publications in 2015-2016:


Public outreach

- The main highlight of 2015 was Lightfest, which is fully detailed in the Outreach section of this report. Aston University’s first ever artist in residence, Chris Plant, worked with the photonics experts to create a stunning light installation for the inaugural Lightfest event, held at the Library of Birmingham. Taking inspiration from the innovative ways in which the AIT use optical fibres, laser beams and advanced LED technology, he developed his installation to make people experience light in a fundamentally different way. (See image 1.)
- AIT organised two engagement events for local secondary schools in 2015, aimed at establishing continuous network partnership between the AIT and science and physics teachers in the Greater Birmingham area. The events were attended by science teachers from the High Arcal School, Christopher Whitehead Language College, Barr Beacon School, Bridgnorth Endowed School, Ercall Wood Technology College and Prince Henrys High School. Joint activities were planned with the West Midlands STEMNET (the Science, Technology, Engineering and Mathematics Network) to create opportunities to inspire young people in science.

Key research grants awards and industrial outreach activities

- AIT was awarded the Newton Fund International Exchanges grants with Mexico (Dima Churkin) and (David Webb and Kaiming Zhou) and the Newton Fund Visiting Professorship with Malaysia (Sergei K. Turitsyn).
- AIT was awarded the Erasmus+ International Credit Mobility Programme grant supporting exchanges of PhD students and staff members between Aston University and Novosibirsk University (Russia), in the field of photonics. The programme is focused on mutual sharing of best practice and is led by Dr. Sonia Boscolo, Dr. Dmitry Churkin and Professor Sergei Turitsyn.
- Sergey Sergeyev was awarded the Leverhulme Trust grant: Combined Harnessing of Synchronisation in mode locked lasers.
- Nick Doran and Andrew Ellis were awarded EPSRC project grant UPON - Ultimate Passive Optical Network.
- Kaiming Zhou and David Webb were awarded the Technical Strategy Board grant from the Aerospace Technology Institute - Fuel and Systems Integrated Research.
- Dr. David Benton has been awarded a grant from the Centre for Defence Enterprise to investigate a concept for ‘a low cost method for detecting lasers’.
- AIT was awarded three Marie Skłodowska-Curie actions in the Research and Innovation Staff Exchange (RISE) projects led by Sergei K. Turitsyn and Dmitry Churkin, Alex Rozhin and Misha Sumetsky).
- Three Marie Skłodowska-Curie Fellowships were awarded to AIT in 2015. (See image 1.) Edik Rafailov will host a fellow to carry out research in the area of bio-photonics, Sergei Turitsyn and Stelios Sygletos will be hosting a project in optical communications, and Sergey Sergeyev will host a fellow to carry out research on fibre lasers.
- A Knowledge Transfer Showcase event took place in April 2015. In the Knowledge Transfer Project poster competition, AIT members were involved in both the winning and runner up projects. The winner was a project assisting Gas Data Ltd of Coventry to develop a range of laser based gas monitors for biogas applications, while the runner up involved both AIT and LHS assisting Optimec Ltd to develop a system for high precision monitoring of contact lens shape.
- With the support of European Research Development Fund, AIT have organised 7 half day industrial outreach seminars for local companies throughout the year. We’ve explained the science behind photonics, how it is being used in industry already and how companies might benefit from it.

Organisation of the international conferences and workshops

- AIT, with the Vinca Institute of Nuclear Sciences, University of Belgrade, and the Optical Society of Serbia, co-organised the 5th International School and Conference on Photonics – ‘PHOTONICA2015’ in Belgrade, Serbia. The conference is one of the central events in the International year of Light in Serbia. (See image 3.)
- Sergei Turitsyn and Dmitry Churkin were awarded a grant from the Abdus Salam International Centre for Theoretical Physics and will co-organizes a workshop “Disorder, Interactions, Turbulence and Wave Dynamics: Fundamentals and Applications”.
- Prof. Andrew Ellis, Prof. David Saad and Prof. Sir David Payne (Optical Research Centre, Southampton) organised the Royal Society workshop, ‘Communication networks beyond the capacity crunch’ on 11 and 12 May 2015. The workshop has strong impact on discussion of the
future of broadband communication in the United Kingdom.

Prof. Edik Rafailov co-organised the 3rd “Photonics Meets Biology” summer school in Crete, Greece, from 28 September to 2 October 2015 – an event bringing together experts from world-leading academic centres in order to educate students and young researchers in this cutting edge field.

Sergei Turitsyn and Dmitry Churkin have received a grant from the Max Planck Institute for the Physics of Complex Systems to organise the international workshop, ‘Discrete, Nonlinear and Disordered Optics’ in 2017.

2. The Marie Skłodowska-Curie actions, named after the double Nobel Prize winning Polish-French scientist famed for her work on radioactivity, support researchers at all stages of their careers, irrespective of nationality.

3. Photonica 2015, Belgrad, Serbia

4. Prof. Andrew Ellis explaining how new technologies will prevent the energy consumption of the internet increasing beyond its current high levels.
AiPT Current Awards

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<tr>
<th>Funder</th>
<th>No. Awards</th>
<th>Total Award Value (£)</th>
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<tr>
<td>European Commission</td>
<td>30</td>
<td>£7,991,967</td>
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<td>ESPRC</td>
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<td>£6,528,140</td>
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<td>Leverhulme Trust</td>
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<tr>
<td>ERDF Fibre Optics Phase 2-Photonics</td>
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<td>£385,942</td>
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<tr>
<td>Knowledge Transfer Partnerships</td>
<td>2</td>
<td>£312,203</td>
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<td>The Royal Society</td>
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<td>EPSRC Dorothy Hodgkin Postgraduate Award</td>
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<tr>
<td>Innovative UK</td>
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<td>£385,299</td>
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<tr>
<td>US AIR Force</td>
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<td>Russian Ministry of Education &amp; Science</td>
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<td>DSTL</td>
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<td>II-VI LASER UK LTD</td>
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<td>Other grants</td>
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<td><strong>Total</strong></td>
<td><strong>59</strong></td>
<td><strong>£16,604,650</strong></td>
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AiPT Personnel

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<th></th>
<th>2015</th>
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<tr>
<td>Academic staff</td>
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<tr>
<td>Research staff</td>
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<tr>
<td>Marie-Curie Research Fellows</td>
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<tr>
<td>Research Students</td>
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<td>Project Managers</td>
<td>5</td>
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<td>2</td>
</tr>
<tr>
<td>Technicians</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>119</td>
<td>99</td>
<td>69</td>
</tr>
</tbody>
</table>

**Male** | 87  
**Female** | 18

Dr. Maria Chernyshева, Marie-Curie Fellow, is characterising the spectrum of her fibre laser.
Marie Skłodowska-Curie Individual Fellows

The AiPT has a total of 14 fellows, including 6 new comers that are introduced over the following pages.

Existing fellows:
- Dr. Sergey Kulinich
  MC IIF NPS4FM
- Dr. Jianfeng Li
  MC IIF MIDFIL
- Dr. Naoise MacSuibhne
  MC IEF SOLAS
- Dr. Carlos Marques
  MC IEF POSSIBLE
- Dr. Junsong Peng
  MC IIF ULTRAFIL
- Dr. Qizhen Sun
  MC IIF SOFST
- Dr. Junxi Zhang
  MC IIF Plasm-on-fibre
- Dr. Zuxing Zhang
  MC IIF DISCANT

Amos Martinez
Structured photonics for advanced fibre lasers
Host: Sergei Turitsyn

I completed my PhD at Aston University in 2006. Before re-joining AiPT in July 2015 I worked in The University of Tokyo and Nature Communications.

I am interested in exploring new ways to exploit two-dimensional materials such as graphene, and transition metal dichalcogenides in photonics through their interaction with micro-cavities, in particular fibre-based cavities with the aim of developing new classes of light sources.

I am also interested in exploring alternative approaches to modify the linear and nonlinear optical properties of two-dimensional materials through their interaction with light. While this project originates from a desire to advance our understanding of the fundamental optical properties of these materials, I believe it can also influence applied research in areas such as laser science, nanotechnology and material science.

Biqiang Jiang
Fibre Optic Multi-parametric Biochemical Sensing Technology (FOMBIST)
Host: Prof. Lin Zhang & Dr. Kaiming Zhou

I received my PhD degree in Optical Engineering from Northwestern Polytechnical University (NPU), China, in 2013. Since then, I have worked in the School of Science of NPU as a lecturer. My research interests focus on optical fibre devices and their sensing applications. I have authored/co-authored more than 20 peer reviewed publications and generated nine patents. I joined the AiPT as a Marie Skłodowska-Curie Individual Fellow in 2015. My current project is called as FOMBIST (Fibre Optic Multi-parametric Biochemical Sensing Technology) and aims to develop advanced optical fibre devices and sensing technologies for highly sensitive multi-parametric biochemical measurements. These devices are urgently demanded both from industry and for scientific research and are used for quality control and process study.
Dr. Filipe Ferreira

HSpace - High capacity space division multiplexing systems
Host: Prof. Andrew Ellis

In 2014, I was awarded my Ph.D. degree in Electrical and Computer Engineering with specialization in Telecommunications from the University of Coimbra, Portugal. During my Ph.D., I was the recipient of an industrial fellowship granted by the Portuguese Ministry of Education and Science, and worked simultaneously with Instituto de Telecomunicações, Portugal, and Coriant Portugal. My thesis was focused on high capacity optical transmission systems based on mode division multiplexing.

In September 2014, I joined the AiPT as a Research Fellow. Soon after, I was awarded with a Marie Skłodowska-Curie Individual Fellowship. My fellowship will be dedicated to the development of advanced spatial division multiplexing systems to unlock the capacity of future information systems by enabling the transmission of spatial super-channels over a single fibre. The proposed concept will be implemented using multi-core fibres and few-mode fibres as underlying technology platform along with novel digital signal processing techniques that minimise the mode/core interference and inter mode/core nonlinearities, keeping the required digital processing at realizable levels.
Mohd Zamani Zulkifli

Tunable Mode Random Fibre Laser For Mode Division Multiplexing Laser Source (TUNEMODE)
Host: Prof. Sergei Turitsyn

I am a Marie Curie Research fellow in the Aston Institute of Photonic technologies. My research interests include fiber laser and amplifiers, non-linear fiber and fiber-optic sensors. I received a B.Sc. degree in instrumentation physics from University Putra Malaysia, Selangor, Malaysia, in 2005 and subsequently the M.Sc. and Ph.D. degrees from the University of Malaya, Kuala Lumpur, Malaysia.

Project TUNEMODE targets theoretical and experimental study, design optimization, and development of the spatial mode tuning random fibre laser sources for application in spatial division multiplexing (SDM) telecommunication systems. Conventional fibre lasers, based on rare earth elements such as Erbium and Ytterbium, are not optimized for lasing at modes other than the fundamental mode LP01. The proposed concept will use the flexibility of random fibre lasers (RFL) combined with microfibre technology and fibre Bragg grating (FBG) techniques. Moreover, the tunable laser source generating at various spatial modes will have numerous applications beyond telecommunications. The TUNEMODE is an interdisciplinary project that brings together laser science, fibre optics, theory of disordered systems, and optical engineering.

Petro Lutsyk

FOC4SIP — H2020-MSCA-IF-2014 “Functionalised Organic Complexes for rapid Sensing of Industrial Polluters” (FOC4SIP)
Host: Dr. Alex Rozhin

I received a PhD degree in Physics from the Institute of Physics, National Academy of Sciences of Ukraine (Kyiv), in 2008. Since then, I have worked as a Research Scientist in the Institute of Physics (Kyiv, Ukraine) and the Institute of Physical and Theoretical Chemistry (Wroclaw, Poland). My scientific background and interests are related to research areas of physics, chemistry, and engineering of advanced materials; nanoscience and soft matter technology.

FOC4SIP Fellowship is focused on the development of new organic macromolecular complexes including carbon nanomaterials functionalised by organic molecules for rapid detection of hazardous industrial polluters. Recently, we have developed an efficient molecular-engineering method for detecting carbon nanotubes that involves amplifying their photoluminescent signal through the formation of ionic complexes with tailorable polymethine dyes. The dye absorbs visible light and transfers the energy of this light to the CNT emitting in NIR.
Research Areas

1. Nonlinear Photonics and Signal Processing

We aim to harness the potential of nonlinear system response to create new engineering concepts. Nonlinear photonics is the science and technology of light (photon) generation, manipulation and detection through nonlinear optical processes in structures, devices and systems. The focus of our research is the study of various phenomena encountered by the manipulation of fundamental properties of light, such as the intensity profile, phase and state of polarisation, in optical fibre systems, as well as the new applications already made possible by the nonlinear fibre-optic technology.

Researchers in this group:

Academic Staff
Prof. Keith Blow, Dr. Sonia Boscolo, Dr. Sergey Sergeyev, Prof. Sergei Turitsyn, Dr. Elena Turitsyna.

Research Fellows
Dr. Junsong Peng, Dr. Mariia Sorokina, Dr. Chengbo Mou, Dr. Yaroslav Prylepsky, Dr. Vladimir Kalashnikov, Dr. Stanislav Kolpakov, Dr. Nikita Tarasov, Dr. Dmitry Churkin.

Research Students
Mr. Auro Michele Perego, Mr. Huseyin Karakuzu, Mr. Hani Kbashi.

Optical encryption based on varying cavity length.

Jointly with our collaborators in France and Spain, we presented a new scheme for secret key exchange involving varying the cavity length of an ultra-long fibre laser. Unlike schemes that rely on random changes to the cavity losses, the proposed scheme employs random variations to the free spectral range of the laser cavity, ensuring above-threshold operation. It is based on the realisation that the free spectral range of laser cavity can be used as an information carrier. We demonstrate the scheme experimentally using a 50-km-long fibre laser to link two users, both of whom can randomly add an extra 1-km-long fibre segment. While the classical scheme does not ensure the same security as quantum key distribution, it provides enhanced security beyond standard software protocols and can be implemented using standard components.

Regenerative Fourier transform.

Regenerator for regular rectangular quadrature-amplitude-modulation (QAM) signals based on non-linear optical loop mirror configuration. The scheme achieves suppression of noise distortion on both signal quadratures through the realisation of two orthogonal regenerative Fourier transformations. The RFT transfer function is the first-order Fourier series expansion of the step-wise transfer function; therefore, it represents a smooth and close approximation of an ideal regenerator. Numerical simulations show the performance of the scheme for high constellation complexities (including 256-QAM formats).

Dark and bright vector rogue waves.

For an erbium-doped mode-locked fibre laser, we demonstrate the first experimental and theoretical evidence of new types of dark and bright vector rogue waves which result from polarisation switching between two orthogonal states of polarisation. The underlying physics comprises an interplay between anisotropy and cavity birefringence tuning, which enables rogue waves control.

Passively mode-locked Nyquist laser.

We propose a novel, simple approach to the design of a Nyquist laser, which relies on nonlinear in-cavity pulse dynamics and pulse shaping by an in-cavity flat-top spectral filter in a passively mode-locked fiber laser. An improved approach, based on the use of a filter’s profile with a corrective convex top, is also proposed to compensate for the concavity of the pulse spectrum obtained after nonlinear expansion in the fiber. The need for large nonlinear phase accumulation in the fiber is thereby relaxed. We numerically show the possibility to achieve sinc-shaped Nyquist pulses of high quality and widely tunable bandwidth with the proposed scheme.
Inverse four-wave mixing.

We present a new nonlinear self-action effect—self-parametric amplification—which reveals itself as optical spectrum narrowing in normal dispersion fibre, leading to very stable propagation with a distinctive spectral distribution. The narrowing results from inverse four-wave mixing, resembling an effective parametric amplification of the central part of the spectrum by energy transfer from the spectral tails. Self-parametric amplification and the observed stable nonlinear spectral propagation with a random temporal waveform can find applications in optical communications and high-power fibre lasers with nonlinear intra-cavity dynamics.

Nonlinear comb generation for astronomy.

In collaboration with groups in Germany and Argentina, we have studied the generation of optical combs suitable for application in calibration of astronomical spectrographs. A two stage process is considered. In the first fibre, standard NLS evolution leads to soliton like compression of the beat between two CW lasers. In the second stage the signal is amplified leading to further compression of the pulses and a corresponding expansion of the frequency comb bandwidth.

Key publications of the group in 2015


Grants


The Leverhulme Trust Visiting Professorship for Yuri Kivshar, 2015-2016.


Awards

The Leverhulme Trust Research Project Grant “Combined harnessing of synchronisation in mode locked fibre lasers”. PI: Dr. Sergey Sergeyev. 2015-2018.

The Leverhulme Trust Visiting Professorship for Yuri Kivshar, 2015-2016.

Erasmus+ KA107 , Mobility with partner countries (2015-1-UK01-KA107-012618). PIs: Dr. Sonia Boscolo, Prof. Sergei K. Turitsyn. 2015/16.
2. Optical fibre sensing

Originally developed for communications purposes, optical fibres now form the basis of a sensing technology that offers some key advantages:

– The low fibre loss permits sensing over long distances
– The dielectric nature of optical fibres renders them immune to electromagnetic interference
– The small size of optical fibres allows them to be embedded inside modern composite materials
– Techniques exist to create hundreds of sensors along a single fibre

Researchers in this group:

Academic Staff
Prof. Lin Zhang
Dr. Kate Sugden
Prof. David Webb
Dr. Kaiming Zhou

Research Fellows
Dr. Graham Lee
Dr. Amos Martinez
Dr. Carlos Marques
Dr. Thomas Alisop
Dr. Mykhaylo Dubov
Dr. Wei Zhang
Dr. Chengbo Mou
Dr. Neil Gordon
Dr. David Benton
Dr. Zhijun Yan
Dr. Junxi Zhang

Dr. Biqiang Jiang
Dr. Qizhen Sun
Mr. Guolu Yin
Research Students
Ms. Sandra Donohoe
Mr. Luifu Khan
Mr. Andreas Pospori
Mr. Fangcheng Chen
Mr. Michal Zubel
Mr. Changle Wang
Mr. Zhongyuan Sun
Mr. Abdulyesir Badmos
Mr. Adenowo Gbadebo
Ms. Sophie Acheroy

R&D ranges from fundamental new technology development through to prototype construction for specific applications with industry partners.

Food safety

As a Key Enabling Technology, photonics can find its way into many different areas of life. One example from 2015 is a project AiPT carried out with three UK companies, Branscan Ltd, Arden Photonics Ltd and Warburtons Bakery. The project successfully delivered a prototype sensing system capable of monitoring the moisture level, protein content and particle size of flour in a grain mill. The system has at its heart Aston’s tilted fibre grating technology, used here to couple light out of the side of an optical fibre to permit spectroscopic measurements of the fibre environment.

Gas sensing with nanoparticles

Some of our more fundamental sensing research, funded by the EPSRC, has brought together researchers from AiPT and the Nanoscience Research Group at Aston along with colleagues from Plymouth University. By combining an ultra-high resolution plasmonic sensing platform with a coating of carbon nanotubes, we have provided the first demonstration of the use of the optical properties of carbon nanotubes to provide a gas-specific response, in this case to CO₂.
The approach is much more generic than this though, since techniques are available to functionalise carbon nanotubes to provide sensitivity to other industrially important gases.

Professor David Webb, Deputy Director of AIPTRT

“Through the latter part of 2015, increasing amounts of my time have been devoted to detailed planning of a new suite of laboratories for AIPTRT. The move, likely to occur in mid 2017, will consolidate our activities, providing additional space to accommodate our current expansion and allow redevelopment of the North Wing of the Main Building where most of our laboratories are currently situated.”

Key publications of the group in 2015

1. Marques C A F, Peng G-D and Webb D J
   2015 Highly sensitive liquid level monitoring system utilizing polymer fiber Bragg gratings
   Optics Express 23 6058-72

   Photonic gas sensors exploiting directly the optical properties of hybrid carbon nanotube
   localized surface plasmon structures Light: Science & Applications (2016) 5, e16036

3. Luo, B., Yan, Z., Sun, Z., Liu, Y., Zhao, M.,
   Zhang, L., Biosensor based on excessively tilted fiber grating in thin-cladding optical fiber
   for sensitive and selective detection of low glucose concentration, Optics Express, 23, 32429-40.

   and gratings assisted multifunctional fiber sensing system, IEEE Sensors Journal. 15, 8,
   p. 4660-6.

5. Benjamin J. Coldrick, Colin Richards, Kate Sugden, James S. Wolffsohn, Thomas E. Drew,
   Developments in contact lens measurement: A comparative study of industry standard geometric
   inspection and optical coherence tomography, Contact Lens and Anterior Eye, pii: S1367-
   0484(16)30002-9.

Grants

TRIPOD (Training and Research in Polymer Optical Devices), EC - Marie Curie ITN, 2013-2017
SAFUEL (The SAFer FUEL system), EC – STREP, 2012-2016
Grating and Waveguide Plasmonic Sensors, EPSRC, 2012-2016
FSIR, Innovate-UK (ATI), 2015-2016
POSSIBLE (Polymer Optical Sensing System Innovation Brings Leadership Education), EC – Marie Curie IEF, 2014-2016
Gas Sensing, KTP, 2013-2015
SOFST, EC – Marie Curie IEF, 2014-2016
Plasm-on-fibre, EC – Marie Curie IEF, 2014-2016
FOMBIST, EC – Marie Curie IEF, 2015-2017
To develop a new generation of innovative soft contact lens measuring instruments, KTP, 2013-2016
Pathogen detection, CDE, 2015-2016
3. Femtosecond lasers

Ultrafast femtosecond lasers have become an indispensable tool in science, technology and engineering with applications ranging from ultrafast spectroscopy, laser controlled chemical reactions, non-invasive surgery, high precision metrology, and material processing.

At AiPT, we have a selection of femtosecond lasers that are available to fabricate devices with high degree of precision. These lasers allow us to work with a diverse range of media, including ones that are normally not accessible with more conventional material processing techniques.

Researchers in this group:

Academic Staff
Dr. Kate Sugden
Dr. Mykhaylo Dubov
Dr. Kaiming Zhou
Dr. Neil Gordon
Dr. Graham Lee
Dr. Vladimir Mezentsev
Prof. David Webb

Ultra short pulse lasers permit the modification of materials on a sub-wavelength scale and are becoming an important tool for micro-fabrication.

In 2015 we have extended our work on micro-channels in optical fibres for liquid and gas sensing with femtosecond laser assisted chemical etching expanding the design parameters for novel sensing devices. This includes the fabrication of microholes, microslots, helical channel around the core and Fabry-Pérot-based refractometers. The Fabry-Pérot refractometer was formed by positioning a microchannel between two femtosecond laser inscribed point-by-point fibre Bragg gratings. R.I. sensitivities up to 2.75 nm/RIU was also demonstrated 1.

Metrology

The ultrafast laser was used for the detection of fuel level in an Innovate UK funded research programme in collaboration with Airbus. Due to the ultrashort nature of a femtosecond laser, its pulses can be used to resolve distances with high precision. In combination with a time resolved detection method, time correlated single photon counting (TCSPC) technique, the very weak reflected light, another challenge facing surface detection for liquid, can be detected and give space detection with high resolution.

Waveguide inscription

In a collaboration with scientists of Australia, we proposed a return to the original intent of the Type I and II grating classifications, one intrinsically linked to material modification associated with working below or above the optical damage threshold of the irradiated substrate (glass or crystal), optical damage in this case referring to the regime where the target substrate undergoes a rapid change in refractive index in response to a monotonically varying incident laser pulse energy 2.

Dual gratings

One of the advantages of femtosecond laser fabrication is highly localised modification, making it possible to inscribe fibre gratings of different parameters at different location of the core of an optical fibre. In addition, by not requiring photosensitive optical fibre as UV laser technology, fs lasers can inscribe fibre gratings in a more diverse range of optical fibre, including Er- or Yb-doped active fibre. With two channel fibre gratings fabricated at the same section of optical fibre, we implemented a ring cavity fibre laser with the capability with switchable wavelength 3.
Sapphire substrates are widely used for the manufacturing of blue and green LEDs and diode lasers. Dicing of sapphire wafers with deposited GaN device structures is therefore an important technological challenge. We have studied the possibility of using infrared sub-picosecond pulses for dicing of sapphire wafers with widths of both 350 and 75 micrometres. We have observed that pulses with a length of 100-400 femtosecond at a wavelength of 800 nm allows successful cutting of the sapphire substrate as well as having the advantages of a “stealth dicing” method.

Key publications of the group in 2015


Grants
Fuel system integrated research, Innovate UK in collaboration with Airbus, £220,000

Fibre-Optic Multi-parametric Biochemical Sensing Technology, EU Horizon 2020 Marie Skłodowska-Curie actions, £180,000.
4. Fibre Lasers

Understanding the fundamental physics behind laser generation in nonlinear fibre resonators is critically important for development of novel high-performance laser sources offering turn-key solutions for practical applications. By combining advanced theoretical and experimental concepts, we are able to achieve breakthrough understanding of the operational principles and develop new laser sources of the likes of random fibre lasers, turbulent quasi-CW fibre lasers, and passively mode-locked fibre lasers.

Researchers in this group:

Academic Staff
Prof. Sergei Turitsyn, Dr. Sergey Sergeyev

Research Fellows
Dr. Junsong Peng, Dr. Chengbo Mou, Dr. Stanislav Kolpakov, Dr. Vladislav Dvoyrin, Dr. Amos Martinez, Dr. Srikanth Sugavanam, Dr. Nikita Tarasov, Dr. Zamani Zulkifli, Dr. Dmitry Churkin

Research Students
Mr Auro Perego

Visitors
Prof. Valentin Freilikher, Dr. Ilya Vatnik, Dr. Ivan Terekhov

Spatio-temporal generation regimes in lasers

Conventionally, lasers are the epitome of stable optical output. While there is an ever increasing demand for shorter pulses and higher energies, these conditions lead to nonlinear interaction between light and the fibre medium, resulting in seemingly chaotic dynamics in long fibre cavities. This in its turn limits the optimum performance achievable in such laser systems. Although experimentalists tend to avoid unstable regimes because of challenges posed by their irregularity, these highly non-linear generation regimes must be understood to discover new modalities and develop better lasers. To meet this challenge, we change a paradigm of thought - usually lasers are thought to operate in a distinct temporal regime. Instead, we present experimental evidence that the laser operates in a distinct, albeit complex and dynamic spatio-temporal regime. Different spatio-temporal regimes could have different periodicity properties over different scales. This shift in paradigm is set to bring new insights into rich underlying nonlinear physics of not only practical active and passive-cavity photonic systems, but also other physical systems from fields ranging from studies of brain activities to astrophysics, which exhibit a similar co-existence and interplay of processes featuring distinct spatio-temporal scales.

Cyclic wave kinetics

Kinetic theory is a mathematical framework that is used to describe nonlinear systems with a large number of degrees of freedom. Traditional kinetics describes slow evolution to equilibrium via numerous weakly nonlinear interactions and fails for very important class of dissipative (active) optical systems with cyclic gain and losses, such as e.g. lasers. To meet the challenge of kinetic description of a laser, we introduce a new class of wave kinetic systems – active cyclic systems – and a new kinetic formalism for its description. To make a kinetic description of active cyclic systems, we use field theory apparatus. This results in a breakthrough in a very different field – we make first ever description of recently emerged random fibre lasers. More generally, we propose first ever nonlinear kinetic theory of laser radiation (not limited to class of random lasers). We carry out experiments whose results support the theory. The formalism is general and could be applied for a wide class of kinetic problems, for example meteorological and biological cycles.

Isolator-free passively Q-switched fibre laser at 2µm

Ultrafast mid-infrared fibre lasers have found applications in metrology, gas identification, and ranging. However, fibre components at this wavelength region are still quite expensive and complicated to manufacture. We have proposed a novel modified ring fibre laser configuration of Thulium-doped fibre laser, so-called theta or Yin-Yang cavity, which features S-shaped feedback. Such approach helps to ease the configuration and decrease the cost of the laser resonator by removing in-line fibre optical isolator. The fibre laser cavity is formed by two coupler-based nonlinear optical loop mirrors. Varying the coupling ratios directly alters the total power distribution within the cavity and modifies its gain and pulse dynamics behaviour. Hence, the design opens the opportunities to redefine the operation direction.

Q-switched and mode-locked fibre lasers with large angle tilted fibre brag grating

Tilted fibre gratings possess unique polarization spectrum characteristics. They are capable to tap out the s-light and propagate the p-light based on the Brewster’s law and, hence, has been used as a new type of in-fibre polarizer. The polarization dependence of the large angle-tilted fibre gratings can induce nonlinear polarisation evolution effect in the laser cavity and induce pulsed laser generation, i.e. passive Q-switching or mode-locking. We have proposed and demonstrated both Q-switched and mode-locked all-fibre laser operating...
at switchable single wavelength and dual wavelength. We proved that the use of large angle-tilted fibre gratings as an in-line polariser in a ultrafast fibre lasers provides several advantages compared to bulk polarisers, including low insertion loss, high integrability and less temperature sensitivity.

**Ginzburg-Landau turbulence in quasi-CW fiber lasers**

Fiber lasers operating via Raman gain or rare-earth-doped active fibers are widely used as sources of continuous wave (CW) radiation. However, these lasers are only quasi-CW: their intensity fluctuates strongly on short time scales. We have shown how the framework of the complex Ginzburg–Landau equations (GLEs), which are well known as an efficient model of mode-locked fiber lasers, can be applied for the description of quasi-CW fiber lasers. The vector Ginzburg–Landau model of a Raman fiber laser describes the experimentally observed turbulent-like intensity dynamics, as well as polarization rogue waves. Our results imply that the very essence of both quasi-CW fiber lasers like the Raman lasers above and partially mode-locked fiber lasers should be revisited, and opens the debate about the common underlying physics of operation of lasers of dramatically different types.

**Key publications of the group in 2015**


2. Maria Chernysheva, Chengbo Mou, Raz Arif, Mohammed AlAraini, Mark Rummel, Sergei Turitsyn, Alex Rozhin “High power Q-switched Thulium doped fibre laser using carbon nanotube polymer composite saturable absorber” Scientific reports (accepted 2015)


**Grants**

- Erasmus+ Programme, Staff and student mobility for teaching and training with Russia, (Aston Uni - coordinator), 2015-2016
- Newton Fund, International Exchanges Programme, Visiting Researcher – Dr. E. Chaikina (Mexico), 2015-2016

**Real-time intensity domain measurements using spatio-temporal dynamics**

**Isolator-free passively Q-switched fibre laser at 2 um.**

**Unifying the physics of partially mode locked and quasi-CW fibre lasers**

**Wave kinetics of random fibre lasers**
5. Nanomaterials Photonics

The nanomaterials photonics group has an active interdisciplinary research programme funded by, BBSRC, FP7 and Horizon 2020 on development and utilization of functional nanomaterials such as carbon nanotubes, graphene, CdS, ZnO for:

- photonic sensors for food and environmental monitoring,
- ultra-fast fibre laser systems,
- functional thin film coatings,
- drug delivery systems.

The group has state-of-the-art facilities for wet chemistry processing of nanomaterials, and fabrication of polymer nano-composites and nano-ink.

We operate absorption/transmission spectroscopy, photoluminescence excitation –emission spectroscopy and micro Raman spectroscopy for optical characterisation of photonic materials.

We integrate functional nanomaterials in planar photonic structures, fibre Bragg gratings, plasmonic structures, fibre laser cavities with the aim to achieve unprecedented sensitivity for gas molecules, micro bacteria, hazardous agents and to realise novel laser generation regimes.

Researchers in this group:

**Academic Staff**
- Dr. Alex Rozhin

**Research Fellows**
- Dr. Sergey Kulinich
- Dr. Petro Lutsyk
- Dr. Chengbo Mou
- Dr. Maria Chernysheva

**Research Students**
- Mrs Raz Arif
- Mr Mohammed AlAraimi
- Mr Peter Stone

**Visitors**
- Dr. Igor Yanchuk
- Dr. Volodymyr Yukhymchuk
- Mr Semeon Ponomarov
- Mr Oleksandr Hreshchuk
- Mr Serhii Krasnovid

The special structure of nanomaterials gives rise to their amazing properties. The ability to manipulate the structure and composition on the nanoscale provides very large opportunities to create new materials with superior performance for new products and devices. Since optical properties of nanomaterials can be controlled by changing their size, shape and aspect ratio, as well as via their surface modification, nanomaterials are prime candidates as building blocks for photonic systems.

A range of semiconductor and oxide nanomaterials (ZnO, SnO2, CdO and CdS) were synthesized via laser ablation and chemical routes. The nanomaterials were prepared with pure or passivated surfaces, which was realized either in situ or ex situ, i.e. during the material preparation or afterwards, if necessary. Materials then used to produce either polymer nanocomposites or nano-ink for development of photonic systems.

Graphene is promising material for a number of applications in photonics such as optical modulators, saturable e absorbers and photo diodes. We demonstrated poor fluorinated graphene sheets produced by thermal exfoliation embedding in carboxymethylcellulose polymer composite (GCMC) as an efficient mode locker for erbium doped fibre laser for generation of sub-ps soliton type pulses.

We developed functional coating with the ant-icing (or icephobic) performance. The results were highlighted in Advances in Engineering!

Key publications of the group in 2015


**Grants**

“Carbon Nanotubes Technologies in Pulsed Fibre Lasers for Telecom and Sensing Applications”, Proposal No 269271- Acronym: TeLaSens FP7 Marie Currie International Research Staff exchange Scheme Project

“Nanomaterial Photonic Sensors for Food Manufacturing”, Marie Curie International Incoming Fellowship (FP7-PEOPLE-2012-IIF, Proposal number: 330516),

BBSRC Industrial Case PhD studentship “Developing new tools for understanding the in vivo distribution of vaccine adjuvants”

Functionalised Organic Complexes for rapid Sensing of Industrial Polluters” Marie Skłodowska-Curie Individual European Fellowship (H2020-MSCA-IF-2014_ST, Proposal #: 654733)

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**Our nanomaterials can greatly enhance performance of many photonic systems!**
6. Optoelectronics and Biomedical Photonics

Our research focuses on development and application of photonic devices for biology and medicine. In particular, we focus on non- and minimally invasive cancers diagnostics and treatment, laser-based Doppler flowmetry, fluorescent tissue analysis, multi-photon imaging and spectroscopic techniques in biomedicine. Photonic devices we develop include compact, tunable, high-power ultrafast and CW lasers in visible, near and mid IR spectral regions, THz sources and detectors and high-brightness white LEDs.

Researchers in this group:

Academic Staff
Prof. Edik Rafailov
Dr. Natalia Bazieva

Research Fellows
Dr. Ksenia Fedorova
Dr. Andrei Gorodetsky
Dr. Karina Litvinova
Dr. Sergei Sokolovsky
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Research Students
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Mr. Amit Yadav
Mr. Modestas Zulonas

Visitors
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Ms. Alessandra Cecchini
Mr. Ivo Leite
Mr. Shamil Mirkhanov
Mr. Thomas Rabl
Mr. Salvatore Smirni
Mr. Sergey Turtayev

High CRI White light LEDs

Light emitting diode (LED)-based lighting solutions with their superior efficiency are rapidly replacing the traditional sources for indoor and outdoor applications alike. The ability of these sources to render true colours of an object is of critical importance for an adequate and appropriate visual appearance at place like art galleries, museums, hospitals, and exhibitions. For achieving a high colour rendering index (CRI), broad emission linewidth is suitable. In an effort to achieve this, various approaches to realize white emission are being applied.

In the frame of the €11.8M FP7 IP Project “NEWLED” we work on the development of high brightness white LEDs with high CRI and efficacies. Furthermore, solutions to improve quantum efficiencies and reduce losses are targeted from epitaxial growth to application. In 2015, we demonstrated a monolithic white LED with CCT tuneable from warm (3500 K) to cool (13000 K) white. We have also demonstrated a very high value of CRI, Ra = 67, from dual wavelength monolithic, phosphor free devices, for the first time to the best of our knowledge.

Terahertz Laser Sources and their applications

Compact and tunable semiconductor terahertz sources providing direct electrical control, efficient operation at room temperatures and device integration opportunities are of great interest for the past two decades. One of the most well-established techniques for terahertz generation utilises photoconductive antennas driven by ultrafast pulsed or dual-wavelength continuous wave laser systems, though some limitations, such as confined optical wavelength pumping range and thermal breakdown, still exist.

Our group proposed the use of quantum dot-based semiconductor materials, which have unique carrier dynamics and material properties. These materials can help to overcome limitations and enable efficient optical-to-terahertz signal conversion at room temperatures.

We proposed the construction of novel and versatile terahertz transceiver systems based on quantum dot semiconductor devices. We demonstrated their configurability, energy-dependent optical and electronic characteristics and the resonant response to optical pump wavelength. Terahertz signal generation and detection at energies that resonantly excite only the implanted quantum dots, shown recently, opens the potential for using compact quantum dot-based semiconductor lasers (the main area of group’s expertise) as pump sources. We ran proof-of-concept experiments that showed quantum dot-based samples to have higher optical pump damage thresholds and reduced carrier lifetime with increasing pump power.

The results were presented by two talks at CLEO Europe 2015 and one presentation at Photonica 2015 in Belgrade.

Broadly tunable second harmonic generation

The development of compact, widely tunable laser sources in the visible spectral region is an attractive subject, motivated by demand
from the biomedical community, where practical laser sources are required for use in photodynamic therapy, laser-Doppler velocimetry, flow cytometry, spectroscopy, and advanced imaging techniques. However, these applications normally require a number of lasers to cover the whole visible spectrum, making the system bulky, expensive, and complex to operate. Therefore, a laser system that will be cost effective, easy to use, shoebox sized, and tunable across the visible spectrum is of great interest.

Currently, there is no single compact laser system capable of tuning over the whole visible spectral range with the output powers required for most biomedical applications. In this respect, semiconductor lasers with their small size, high efficiency, reliability, and low cost in combination with second-harmonic generation phenomenon are promising for the realization of such sources, enabling a spectrally flexible tool for biomedical applications.

Our group has demonstrated a number of compact laser sources operating in the visible spectral region in the CW and pulsed regimes. Among them the recently demonstrated compact yellow-to-red (574 nm – 647 nm) tunable all-room-temperature CW laser source, which is based on frequency doubling of a broadly tunable InAs/GaAs quantum dot external cavity diode laser in PPKTP crystal waveguides. The presented widely tunable laser source with the unique spectral coverage represents an important step toward a compact, efficient, and versatile laser source that can replace available, inefficient, and bulky visible lasers.

Biomedical photonics
For years, photonics based techniques have been employed all over the world to screen, diagnose and treat many medical conditions. Autofluorescence diagnosis has come to the fore, particularly for cancer diagnosis. Of special interest is urinary bladder cancer, which is one of the top ten most prevalent cancers worldwide.

The multi-functional diagnostic system “LAKK-M” was used to assess autofluorescence profiles of healthy and cancerous bladder tissue to identify novel biomarkers of the disease. Statistically significant differences were observed in the optical redox ratio (a measure of tissue metabolic activity), the amplitude of endogenous porphyrins and the NADH/porphyrin ratio between tissue types. We designed a computer simulator optical 3D bladder cross-sectional model to allow for the study of light propagation by a wide range of wavelengths through bladder tissue. These findings could advance understanding of bladder cancer and aid in the development of new techniques for detection and surveillance.

Key publications of the group in 2015
7. Optical Communications

Communication services are critical to the people of the UK and the British economy, with over 99% of our data being carried around the country and beyond by optical fibre communication networks which rely on photonics technology. These optical systems are being deployed ever-closer to the end-user, at home, at work, and on the move, and are critical to our modern information society. AIPIT’s optical communications research group is working on several key aspects of optical fibre communications to enable society’s every increasing demands for information.

Researchers in this group:

Academic Staff
Prof. Sergei Turitsyn, Prof. Andrew Ellis, Prof. Keith Blow, Prof. Nick Doran, Prof. David Payne, Dr. Paul Harper, Dr. Wladek Forysiak, Dr. Stylianos Sygletos, Dr. Sergey Sergeyev.

Research Fellows
Dr. Atala El-Taher, Dr. Filipe Ferreira, Dr. Naoise MacSuibhne, Dr. Marc Stephens, Dr. Mary McCarthy, Dr. Ian Phillips, Dr. Christian Sanchez Costa, Dr. Mariia Sorokina, Dr. Son Thai Le, Dr. Mingming Tan, Dr. Lukasz Krzczanowic, Dr. Christos Tsekrekos, Dr. Lida Sadeghion.

Research Students
Mr Vladimir Gordienko, Ms Tingting Zhang, Mr Morteza Kamalian Kopae, Mr Asif Iqbal, Mr Mohammad Al-Khateeb.

Core and Access Networks

Having broken the nonlinear Shannon limit through nonlinearity compensation and establishing a thorough understanding of the nonlinear interaction between communication signals and noise associated with signal amplification, we have investigated techniques to break this limit as well. By distributing optical phase conjugators along the transmission line, rather than allowing the interaction to accumulate along the entire transmission line, each successive fibre section (separated by OPCs) compensates the previous section significantly reducing the net interaction length. For a long haul transmission link, this approach enables the system performance to be more than doubled.

At the same time, traffic studies revealed the impact of optical phase conjugation deployment at network level. The OPCs placement and the launched optical power into the fibre links proved critical parameters in getting the efficiency benefits of this technique.

Nonlinear amplification

The Aston Communications group is actively pursuing research into optical amplifier technology in order to help supersede Erbium Doped Fibre Amplifiers (EDFAs). EDFAs can provide ~35nm of gain bandwidth which may not be adequate in a future capacity limited, data driven world. One promising technique to extend this bandwidth is to leverage nonlinear effects in optical fibre to provide gain: typically a high power pump light beam can create additional signal photons either via the well-known Raman effect or via parametric mixing processes. The latter is normally termed a Fibre Optical Parametric Amplifier (FOPA).

The FOPA offers potential gain bandwidths as high as 200nm using novel dispersion-stable highly nonlinear fibres (HNLFs). One limitation of the FOPA is the generation of undesired mixing products when using multiple input signals for amplification, which can interfere with the amplified signals and thus act as crosstalk, decreasing the effective optical signal to noise ratio (OSNR) and hence received performance. The Aston team have recently experimentally demonstrated for the first time that by additionally incorporating a counter-propagating Raman pump within a FOPA, the crosstalk can be reduced in magnitude by up to 6dB compared with a standard FOPA.

Raman fibre laser based amplification

A distributed amplifier provides amplification along the length of the actual transmission fibre improving the signal-to-noise ratio of the system. Distributed Raman amplifiers have been increasingly deployed in both long-haul and unrepeatered transmission systems. Ideally, the signal power profile would be perfectly uniform to minimize the impact of noise. This can be achieved by using a novel amplifier configuration - Raman fibre laser (RFL) based amplification – which uses second order pumping and the passive Fabry Bragg grating (FBG) to create a first order ultra-long fibre laser to amplify the signal.

Our recent work provides a detailed investigation of the impact of second order forward propagated Raman pumping on long-haul 100Gbit/s repeated transmission using Raman fibre laser based amplifications. Our results show that whilst using FW-pumping minimises the signal power variation, the performance penalty due to relative intensity noise (RIN) associated with forward Raman pumping was too great for any overall advantage to be seen. However, by using a random DFB fiber laser based configuration...
the RIN can be reduced making forward pumping feasible. This scheme offers the best transmission performance whilst maintaining a low signal power variation, and as such it can be highly suitable for different nonlinearity compensation schemes.

**Space Division Multiplexing**

Space division multiplexing (SDM) has recently received great attention a promising technology to increase system capacity. Parallel transmission of N information signals can be accomplished by exploiting the guiding modes of a few-mode fibre (FMF). However, the optical link and the transceiver must be designed in order to cope with the arising impairments such as modal coupling and differential mode delay.

Our recent work includes the detailed investigation of the group delay statistics in a few mode fibre system operating in the weak and strong linear coupling regimes as well as in the intermediate coupling regime. We have derived a single expression linking the standard deviation of the group delay spread to the fibre linear mode coupling and we have validated this for any coupling regime, considering up to six linearly polarized guided modes. Also, a DSP code has been developed for the realization of multiple-input multiple-output (MIMO) optical transmission experiments and and we have investigated the required memory length to ensure a minimum acceptable performance in a variety of coupling strength and differential mode group delay conditions of an SDM transmission system.

**Grants**

UNLOC - Unlocking the capacity of optical communications, Engineering and Physical Sciences Research Council, co-PI’s : S. Turitsyn, A. Ellis, P. Harper, L Zhang

PEACE – Petabit energy aware capacity enhancement, Engineering and Physical Sciences Research Council, PI : A. Ellis

FOX-C - Flexible optical cross-connect Nodes enabling next generation optical networking, European Commission, co-PI’s : A. Ellis, S. Sygletos

INSPACE - Spatial-Spectral flexible optical networking enabling solutions for a simplified and efficient SDM, European Commission, co-PI’s : A. Ellis, S. Sygletos

FOPA – Wideband optical communication systems using phase-sensitive/insensitive fibre optical parametric amplifiers, Engineering and Physical Sciences Research Council, PI : N. Doran

DISCUS – The distributed core for unlimited bandwidth supply for all users and services, European Commission, PI’s : N. Doran, D. Payne

**Awards**

UPON – Ultimate passive optical network, Engineering and Physical Sciences Research Council, co-PIs : N. Doran, A. Ellis

TOM3 – Towards manufacturing of Massive WDM metro, Engineering and Physical Sciences Research Council, PI: Wladek Forysiak

Radio, Optical and Digital design for UHD transceivers, co-PI : A. Ellis, Wladek Forysiak, S. Sygletos

INNOVATION – Multi-wavelength regeneration technologies for advanced modulation optical signals, European Commission, co-PIs : S. Turitsyn, S. Sygletos

**Key publications of the group in 2015**


AiPT offers extensive educational opportunities to its students.

We run PhD and Masters level courses, as well as recently launched MSc by research. Aston School of Engineering and Applied Sciences also provides a few BSc courses which may lead to career in photonics too.

Being an active member of a range of European funding schemes, AiPT is currently running two Innovative Training Networks, which bring together universities and companies from different countries to train a new generation of doctoral-level researchers.

**Innovative Training Networks**

**TRIPOD**

TRIPOD is a Marie Curie Initial Training Network located in the field of optical fibre sensors - an area where Europe has developed internationally competitive research and commercial activity. The project has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7/2007-2013. We have brought together an interdisciplinary scientific team with expertise covering all aspects of the sensor fabrication path to enable us to obtain a full understanding of the process, with the aim of enabling us to produce optimised grating sensors, efficiently, repeatably and reliably.

www.tripod-itn.eu

**ICONE**

The ICONE Initial Training Network provides training and education of engineers and researchers within the most advanced optical transmission systems, i.e. high capacity high constellation coherent systems using digital signal processing (DSP). European industry is experiencing an explosive growth in demand for qualified engineers, researchers and staff well trained in all of these fields, both for direct application in the development of products and services for core communication networks. Students graduating from this program will be well placed to fill this gap.

www.iconeproject.com

**PhD students graduated in 2015**

Janarthanan Rasakanthan
Advances in Characterisation, Calibration and Data Processing Speed of Optical Coherence Tomography Systems
Supervisor: Dr. Kate Sugden

Raz Arif
Functional carbon nanotubes for Photonic Applications
Supervisor: Dr. Alex Rozhin

Ada Abang Akpan
Development of Polymer Grating Technology
Supervisor: Prof. David Webb

Srikanth Sugavanam
Real-time Intensity and Spectral Characterization of Fibre Lasers
Supervisor: Prof. Sergei Turitsyn

**Workshop put on for ICONE students**

TRIPOD project participants are giving a lecture on photonics basics at Virum Gymnasium, Denmark.

Aston Institute of Photonic Technologies
Participants of TRIPOD project give a basic introduction to optical fibers and principles of their operation at Virum Gymnasium, Denmark.
PhD graduate 2015

Srikanth Sugavanam

“To do a PhD at AiPT has been one of the best decisions I have taken so far. It has been an enriching and fulfilling experience. The hands-on training approach, together with the available state-of-the-art infrastructure and the innumerable training programmes have helped me to accelerate my learning, and actively contribute to relevant scientific advance in the process. The constant flux of distinguished scientific visitors from all over the world, and the unparalleled opportunity to interact with them one-on-one has been particularly enlightening. Seeing science in action is a thrilling experience, and as an AiPT PhD student, I got the best seat in the house.”
PhD Student Research Areas and Projects

Mr. Mohammad Al-Khateeb
Dispersion and functionalization of carbon nanotubes for photonic applications
Prof. Andrew Ellis

Mr. Mohammed Al Araimi
Experimental demonstration of the extension of non-linear capacity limits in optical fibre networks
Dr. Alex Rozhin

Mr. Abdulyezir Ayomipo Badmos
Advanced optical grating and sensing applications
Prof. Lin Zhang

Mr. Md Asif Iqbal
Advanced Raman amplification and ultra-long Raman fibre laser for long haul coherent optical communication
Dr. Paul Harper

Mr. Adenowo Gbadebo
Advanced method of fabricating Fibre Bragg Gratings
Prof. Sergei Turitsyn

Mr. Vladimir Gordienko
Broadband fibre parametric amplifiers
Prof. Nick Doran

Mr. Huseyin Karakuzu
Microstructured waveguides in z-cut Lithium Niobate
Dr. Sonia Boscolo

Mr. Morteza Kamalian Kopae
Communication systems based on nonlinear Fourier transformation
Prof. Sergei Turitsyn

Mr. Hani Kbashi
Vector optical rogue waves in a fibre laser
Dr. Sergey Sergeyev

Mr. Son Thai Le
Advanced digital signal processing techniques for optical coherent OFDM transmissions
Prof. Sergei Turitsyn

Mr. Teerawat Piromjithpong
Micro-structured optical waveguides for nonlinear-optics and mid-infrared applications
Dr. Sonia Boscolo

Mr. Auro Michele Perego
Nonlinear dynamics of Raman lasers and amplifiers
Prof. Sergei Turitsyn

Mr. Andreas Pospori
Polymer fibre grating UV fabrication and testing
Prof. David J. Webb

Mr. Zhongyuan Sun
Near- and mid-IR fibre grating devices and applications
Prof. Lin Zhang

Mr. Mingming Tan
Raman fibre laser based amplification in coherent transmission systems
Dr. Paul Harper

Mr. Nikita Tarasov
Temporal and spatio-temporal regimes of generation of Raman fibre lasers
Prof. Sergei Turitsyn

Mr. Changle Wang
Fibre gratings in sophisticated fibres (multicore and multimode fibre)
Prof. Lin Zhang

Mr. Amit Yadav
Novel semiconductor based light emitting sources
Prof. Edik Rafailov

Ms. Tingting Zhang
Design and experimental demonstration of energy-efficient super-channel transponders
Prof. Andrew Ellis

Mr. Michal Zubel
Development of polymer optical fibre Bragg grating technology for deployment and interrogation
Prof. David Webb/ Dr. Kate Sugden

Mr. Modestas Zulonas
Highly efficient light emitting devices
Prof. Edik Rafailov

Mr. Ilya Rafailov
The development of novel photonics based techniques for biomedicine
Prof. Lin Zhang

Ms. Sandra Donohoe
Polymer fibre gratings for applications in life and health sciences
Prof. David Webb/ Prof. Chris Hewitt
Community

Industrial Collaboration

Using its specialist equipment and know-how built up over 25 years, AiPT attracts science and technology projects and brings academics and industry professionals together in mutually beneficial collaborations.

The advanced facilities available are typically far beyond the economic reach of SMEs, allowing small-scale businesses to test products and prove concepts to internationally recognised standards.

Photonics R&D has opened up new opportunities in core industry areas such as lighting, automotive and aerospace, advanced manufacturing, energy, construction, health care, environment and food safety.

AiPT helps local companies to grow with ERDF

The development of new photonic technologies in the UK is currently considered by the Department for Business, Innovation and Skills and the Technology Strategy Board among the top priorities in development of innovative high-technology businesses.

The Aston Institute of Photonic Technologies (AiPT) run a programme funded by the European Regional Development Fund (ERDF) to promote and support photonic technology by offering free consultancy and business support to small and medium-sized businesses in Birmingham and West Midlands region.

Through this project we were able to help businesses work together and test out new technologies to identify cost savings and help establish brand new products that will boost profits, support longevity of our regional businesses and help strengthen the local economy.

During the last stage of the project AiPT has helped 51 local companies through the range of consultations, events, lab experiments and reports.

A few examples

MagiLED

MagiLED (UK) Ltd is one of the growing SME in the LED industry in the UK. They have their own design team and assembly facilities.

Based on the high competition in the global LED market, especially when low cost Asian manufacturing business involved in, MagiLED is looking at the market with new perspectives with an emphasis on precisely machined metal material for efficient energy saving purposes.

In collaboration with the AiPT team, MagiLED managed to achieve initial result using the cutting edge ultra-precision femtosecond laser micromachined metal materials which serves as the proof of concept for the next generation LED design and implementation.

KIMAL

Kimal is a medium sized company which develops catheters and associated kits for a range of medical requirements. These catheters are used for both the introduction of medications and removal of fluids from patients during surgical procedures. At present these devices are purely passive however company believes that there is scope to add additional functionality to produce a more useful product and increase their added value. Initially, Kimal was not familiar with the latest achievements in the field of photonic sensors but were attracted to the possibility of remote measurement with light.

The company was aware that glass based optical fibres would not be acceptable for many medical applications due to safety concerns should the fibre break. AiPT described the range of properties that can be measured with photonic sensors. There was also some discussion about progress in plastic fibres.

The company was interested in both photonic sensors and photonic laser micro-machining. Following the meeting, the company made a list of 3 possible programmes where they had an interest and it was agreed that the ERDF team should evaluate these and write a report.

The ERDF team was able to successfully micro-machine the surface of a catheter making both holes and writing shapes.

The second project could not be completed due to the non-availability of a solid catheter tube. Finally, an investigation was undertaken into the state of the art with plastic fibres. It was found that these would have suitable performance for temperature sensors and oxygen sensors however it was thought that currently achieved performance with pressure sensors was not sufficient for the company’s requirements.

A possible problem was the lack of commercial availability of suitable plastic fibres.
This problem is currently being addressed by an EU programme known as TRIPOD. Contact was made with the leader of the TRIPOD team (Prof. David Webb) and Kimal were offered the opportunity to assess the fibres produced on this programme and to collaborate with it.

Optimec Ltd develops new generation of innovative soft contact lens measuring equipment

Optimec Ltd (Optimec) has 34 years of experience in the design and manufacture of soft contact lens measuring instruments, and has an understanding of customer and operator requirements and a strong presence in the market.

The manufacturing process for contact lenses has become increasingly precise and accurate through the use of higher performance lathes and moulds. It was essential that Optimec could develop measuring instruments capable of the same degree of precision.

The company has entered into a two and a half year Knowledge Transfer Partnership (KTP) with Dr. Kate Sugden and Dr. Tom Drew of Life and Health Sciences from Aston Institute of Photonic Technologies, to develop a new generation of innovative soft contact lens measuring instruments, utilising novel techniques to match improved accuracy of lens manufacturing processes.

This project was strategically essential for Optimec to maintain and improve its market position through the introduction of a unique product, which will form the platform for a full range of lens measuring instruments that will measure soft contact lenses and also enable expansion into new markets such as intraocular lenses.

The development of interference methods will not only minimise operator dependent variation, but offer improved resolution and accuracy. This enables the de-skilling of these measurements and opens opportunities to address the difficulties of measuring modern non symmetrical lenses such as toric and varifocal. It is also possible to introduce the capability of full 3D mapping, lens ray tracing, simulation, performance assessment capabilities and very advanced metrology compared to current metrology systems.

Dr. Kate Sugden: Working with Optimec has been beneficial to all concerned. The KTP partnership provided an ideal vehicle to work on an exciting new product development. It also instigated a number of student projects and various other areas of common interest.

Fuel & systems integrated research with Airbus

Aston University and Airbus are to collaborate in a part of a significant aerospace technology institute project called “fuel & systems integrated research” (fsir).

The project will evaluate four novel photonic techniques for measuring liquid levels and will develop the most promising of these techniques for potential application to fuel gauging on aircraft.

This project will focus on the development of the next generation of fuel systems and enabling technologies and capabilities. The project will address some of the key challenges facing the development of the next generation of fuel and inerting systems technologies.

Steve Lawson, Project Leader from Airbus “We are happy to be working with Aston University on this project which will enable us to assess these different photonic methods. It’s a new and exciting area and we look forward to the results.”
International Collaborations

The AIPT research can only thrive if we engage with the best people, academic groups and industry around the world. The AIPT International collaboration map shows locations of our international collaborators either in joint papers or projects and how impact of their research is stretching beyond the UK. Over past five years AIPT researchers published papers with more than 70 international groups. For the same period we hosted more than 160 research visitors in AIPT. We are happy to collaborate with the leading academic and research centres from MIT and Princeton to Lawrence Livermore National Laboratory and Bell Labs. With establishing new UK programmes such as the Newton Fund and Global Challenges Research Fund internationalisation of our activities is even more important. In simple terms, AIPT international collaborations provide us access to a wider range of ideas, facilities and resources. Our international links enable our researchers to participate in networks of cutting-edge and innovative activity providing opportunities to do research deeper and faster by working with other leading people in their field. In terms of regular Research Excellence Framework (REF) assessments it is also impact of internationally co-authored work is significantly higher than the overall average. Two our joint research centres: one with the Novosibirsk State University and second with the University of Electronic Science and Technology of China are contributing substantially to high level of our publications.

The development of a joint research centres increase our research capacity and provide us with access to new knowledge, technologies, facilities and infrastructure. The centres operate as distributed laboratories with locations in UK, Russia and China. These collaboration already led to more than 30 joint publications including a number of 4* papers in journals such as Nature Photonics, Physics Reports, Nature Communications, Advances in Optics and Photonics, Physical Review Letters, Light: Science & Applications.
Events

We organise and participate in numerous events throughout the year.

Aston Year of Light Conference

As part of the International Year of Light celebrations, the AiPT hosted a two-day Aston Year of Light workshop on the 6th and 7th of October. The workshop was an initiative of the PhD students coordinated by Mr. Srikanth Sugavanam, Ms. Tania Kilina and Ms. Alisa Nemova. The workshop brought together researchers from diverse walks of optics and photonics, paving the way for collaborative thought and the conceptualisation of disruptive applications.

It was attended by leading researchers in the field of photonics from EU, Australia and the USA. The speakers were prominent figures from the field of photonics - Prof. Manijeh Razeghi (North Western University, USA), Prof. Boris N. Chichkov (Laser Zentrum, Germany), Prof. Yuri Kivshar (Australian National University), Prof. Alexander Szameit (Institute of Applied Physics, Jena, Germany), Prof. Richard Penty (University of Cambridge, UK), Prof. Paul French (Imperial College, UK), Prof. Ian Walmsley (University of Oxford, UK), Mr. Andrew Lowe (Hexagon Metrology, UK) and Prof. Sir David Payne (University of Southampton, UK).

The talks were equally diverse, ranging from quantum optics, biophotonics, and nanophotonics, to optical communications and metrology. Apart from the talks, the sixty attendees interacted one-to-one with the invited speakers and visiting academics during the poster sessions. The best poster award went to Mr. Nikita Tarasov from AiPT, with the second and third prizes going to Mr. Marco Lamperti of Insubria University, Italy, and Mr. Guoqing Wang of the University of Kent. The workshop was well received by all delegates.

Making light work of the internet: how photonics has powered the information revolution

Inaugural Lecture by Professor Andrew Ellis was held on 30th April 2015. Part of Aston University’s inaugural lecture series it was free and open to public. Andrew is Professor of Optical Communications. Before pursuing a career in academia, he previously worked for British Telecom Research Laboratories as a Senior Research Engineer. He has published over 150 journal papers and over 24 patents in the field of Photonics.

During the lecture Andrew Ellis examined the history and future of optical communications, tracing its evolution from Greek mythology to the immense web of fibres used today to transport information ranging from social media to financial transactions, from entertainment to government systems.

He explained, that being a victim of its own success, significant problems lie just around the corner and we shall investigate their causes, and discuss potential solutions, and likely outcomes if solutions are not found.
Seminars
To stay on top of things the AiPT runs a series of seminars. The seminars cover a range of topics, from experimental and theoretical problems of photonics to industrial applications. People from outside the University are welcome to attend the seminar series. Check our website for the upcoming seminars programme.

AiPT Seminar programme 2015

Dr. Josef Vojtech, Head of Research Department of Optical Networks, CESNET
Non telecom transmission in fibre networks

Dr. Konstantin Zloschastiev, Durban University of Technology, South Africa
Logarithmic Schrödinger equation in theory of quantum liquids

Dr. Konstantin Zloschastiev, Durban University of Technology, South Africa
Quantum-statistical approach for non-Hermitian dielectric media and waveguides with dissipation and noise

Prof. Evgeny M.Dianov, Fiber Optics Research Centre of the Russian Academy of Sciences (FORC RAS)
Bismuth-doped optical fibers: a new promising active medium for near IR lasers and amplifiers

Dr. Luc Bergé, French Atomic Energy Commission [CEA]
Filamentation of ultrashort laser pulses and their conversion to the terahertz range in gases

Dr. Pablo Loza-Alvarez, IFSO - The Institute of Photonics Sciences, Barcelona, Spain
Fast volumetric light-sheet microscopy

Dr. Guillaume Huyet, Applied Physics and Instrumentation, Cork Institute of Technology
Properties of frequency swept sources

Prof. Alexander Rubenchik, Lawrence Livermore National Lab (USA)
Physics of additive manufacturing. Promises and problems

Dr. Ekaterina Golovchenko, Fellow at TE Connectivity Ltd
Wearable technology - next frontier in connectivity solutions

Prof. Akihiro Maruta, Osaka University, Japan
Analysis of Rough Wave Phenomenon in Optical Fibers Based on Soliton’s Eigenvalue

Prof. Akihiro Maruta, Osaka University, Japan
Eigenvalue Modulated Optical Transmission

Professor Yuri Kivshar, Australian National University
Recent advances in optical metamatals

All-dielectric metamatals: magnetic light, Fano resonances, and metasurfaces

Dr. Marc Eberhard, Aston University
Massively Parallel Optical Communication System Simulator

Dr. Murilo Baptista, University of Aberdeen, ICSMB
The physics of information transmission in complex networks and applications

Prof. Yuri Kivshar, Nonlinear Physics Center, Australian National University, Canberra
Recent progress in metamaterial and nanophotonics from Down Under

Dr. Alexander Szameit, Institute of Applied Physics, Friedrich Schiller University Jena, Germany
Integrated optical circuits for classical and quantum light

Prof. Martin Cryan
Optical and microwave beamshaping using surface plasmons, plasmas and phase change materials

Prof. Sven Hoefling from, University of Wuerzburg
Mid-infrared Heterostructure Semiconductor Lasers

Dr. Jordi Soriano Fradera, Neurophysics Lab, Barcelona, Spain
Neuronal cultures as model systems: exploring open questions in physics and medicine

Prof. Boris N.Chichkov, Laser Zentrum Hannover e.V., Nanotechnology Department, Germany
3D Nanoengineering and laser printing

Dr. Jinlong Wei, ADVA Optical Networking
Cost and Energy Efficient Optical Links for Data Centre Interconnects

Dr. Alexander Legand, Nanoscribe GmH, Germany
3D µ-Printing by Direct Laser Writing
Prof. Valentin Freilikher, Department of Physics Bar-Ilan University, Israel

*Total disorder as an alternative to perfect periodicity*

Prof. Richard Hogg, Electronic and Electrical Department, University of Sheffield

*Coherently coupled photonic crystal surface emitting lasers*

Dr. Jeroen Nijhof, Photronics Modelling for Ericsson Telecommunications, Italy

*DWDM Network Design and Software Defined Networking*

Prof. Paulo Andre, Instituto de Telecomunicações, Portugal

*Optical/Photonic components for sensing, energy and communications*

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Professor Misha Sumetsky presents at the seminar.
Lightfest Science Festival

On the 25th September, the Aston Institute of Photonic Technologies together with the Library of Birmingham and Flatpack Film Festival hosted the Lightfest science festival - an interactive science exhibition exploring the science of light - in Birmingham (UK) to celebrate Aston University’s forthcoming 50th anniversary and the International Year of Light. The event was hosted at the Library of Birmingham, Europe’s largest public library. Over 12,000 attendees visited the Lightfest. Lightfest was funded by the European Researchers’ Night, a Marie Sklodowska Curie initiative, part of the European Commission Horizon 2020 programme.

“In addition to a series of public lectures, there were lots of demonstrations put on by electronic-engineering students from, including a “laser harp”, an LED light cube and a clever gadget that lights up when you receive an e-mail or social-media post. (I’m sure that could make a great geeky product some day.) Local astronomers were doing a spot of solar-watching from the balcony, while film-makers screened a selection of short light-related films.” Blog post by Matin Durrani, science journalist

Lightfest was the first event of its type hosted by AIFT and it was an enormous success. We think that taking researchers out from their labs and engaging with public is extremely important for development of both parties.

“My children really enjoyed the sessions, especially the electrical paint which we used in the Make a Flashing Greeting Card.” — Lightfest attendee

The Maxwell Torch was specially created for the events throughout Scotland in 2015, the International Year of Light. The International Year of Light celebrates the 150th anniversary of James Clerk Maxwell’s papers that linked together for the first time the electric and magnetic forces. Lightfest was the first event outside Scotland to host the Maxwell Torch.
Lightfest Public Lectures

Lightfest was designed to engage adults and young people and to enable them to identify the importance of light in their lives. Lightfest public lectures are available online at www.lightfest.astonphotronics.uk

Making light work of the Internet
Professor Andrew Ellis, Aston Institute of Photonic Technologies

How does the Internet work? We think about tablets, smart phones and computers, but they are all connected together by optical fibre. This lecture examines the history and future of optical communications, tracing its evolution from Greek mythology to the immense web of fibres used today to transport information ranging from social media to financial transactions, from entertainment to government systems.

Five most amazing photos taken by Hubble space telescope!
Dr. Maggie Aderin-Pocock, BBC The Sky at Night

The BBC presenter shared her fascination for the stars, space and light with a guided tour of the electromagnetic spectrum and described her favourites images from the Hubble telescope.

Light and art: an indivisible relationship
Professor Alessandro Farini, CNR-National Institute of Optics and University of Florence

It is impossible to separate our vision from light, but the relationship between light, vision and perception is not completely clear nowadays.

The Pen is mightier than the Laser? The Power of Light in Literature, Art and Culture
Dr. Greg Lynall, University of Liverpool

How the imaginative power of light inspires us to think about the relationships between science and nature, humanity and the cosmos?

Working at the Speed of Light
Lecture by Professor William O’Neill

The talk showcased the state-of-the-art in modern high power laser technology and their applications. From Nano machining to shipbuilding, and destroying missiles to making spaceships, the applications seem endless.
Lightfest Workshops

How can a Lego robot recognise colours?
Lego Mindstorms robots used colour sensors to recognise colours and played a melody after looking at coloured bricks.

How thick is your hair?
How laser light can be used to measure the size of tiny objects!

Sola light painting
Sola is an artist and photographer who creates amazing images using just a camera, a tripod and a light source (no Photoshop involved). Hands-on 20-minute sessions went extremely well across all ages.

Make a flashing greeting card
With LED, battery and a special electrically conductive paint pen

“Three year old Adam is really proud of his card and has been showing it off to anyone who comes to our house! We also managed to see some of the installations elsewhere on the day.” Adam’s mum

Denisiuk holography
This workshop helped attendees to get acquainted with holography. Guests were able to make their own holograms and take them home afterwards!
Lightfest Demonstrations

All demonstrations were accompanied by clear, easy to understand, posters. All demonstrations were manned by at least two scientists, experts in the field, who were able to explain to the public the phenomena being demonstrated. It was a remarkable atmosphere with kids and general public asking numerous questions and receiving answers from experts in photonics.

How does a message travel through a fibre?
Light and gummy bears
Laser microscope
Fun with optics
Fibre fuse effect or “Tiny Comet”
Phosphor light converters
Laser harp
Interactive LED wall
Magic mirror
LED Chameleon
Biophotonics for wellbeing and healthy life
M-squared multicolour panel
Public Outreach Activities

The Big Bang, UK Young Scientists & Engineers Fair

Aston University attended the annual Big Bang Fair, the largest celebration of science, technology, engineering and maths for young people in the UK from 11 to 14 March at The NEC in Birmingham. The four day event witnessed over 50,000 students pass through the doors saw young people aged from 7-19, engage with the University’s stand in celebrating the subjects. The event aims to inspire and motivate future scientists and engineers through exciting hands on activities and interactive exhibits.

An Aston volunteer at the event, biomedical science student, Isra Ahmed Qureshi

“As an exhibitor representing Aston University I felt that our exhibition at the Big Bang Fair was a huge success and the children engaged enthusiastically in the activities we were presenting. The children had fun making DNA structures out of jelly babies & liquorice as well as extracting DNA from fruits; they found these activities very enjoyable!”
Schools and colleges

With each year AiPT devotes more effort and resources on outreach activities. We are trying to spark an interest and curiosity in engineering among the next generations. Over a year we had organised around twenty workshops, which were attended by 540 secondary school students and 196 primary school students.

“The children were really absorbed by everything they learnt and for the first time ever I had children from all three classes thanking me for the great trip I had organised. I was really taken aback by how much the trip had inspired their thirst for knowledge.” Shabana Minhas, primary school teacher

Legacy was a primary deliverable of Lightfest, therefore we now propose follow on activities for schools and colleges based on demonstrations and workshops of Lightfest. This currently includes 7 physics and electronics based workshops for various age groups, light and optics demonstrations to play with, and educational photonics & optics kits to lend for free.
Publications

2015


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Liu, Y, Li, J, Yan, Z, Li, Z & Zhang, L 2015, ‘2 μm mode-locked thulium doped fiber laser using tilted fiber grating’ in ICO CN 2015 - 14th International Conference on Optical Communications and Networks., Proceedings. IEEE, 14th International Conference on Optical Communications and Networks, Nanjing, China, 3-5 July., 10.1109/ICOCN.2015.7203600


D.V. Churkin, I.V. Kolokolov, E.V. Podivilov, I.D. Vatnik, M.A. Nikulin, S.S. Verseles, I.S. Terekhov, V.V. Lebedev, G.


Invited talks

- C. Mou “All-fibre Mode-locked fibre laser based on Carbon Nanomaterials and Fibre Gratings”, Aston Institute of Photonic Technologies (A IPT), Aston University, Birmingham, UK, B4 7ET
- S.V. Sergeyev, V. Kalashnikov, Ch. Mou, S. Popov, G. Jacobsen, Polarisation phenomena in mode locked fibre lasers and fibre Raman amplifiers, ICTON 2015, Budapest 5-9 July, 2015 (tutorial)
- S. V. Sergeyev, S. A. Kolpakov, Ch. Mou, V. Kalashnikov, G. Jacobsen, S. Popov, and S. K. Turitsyn Polarisation dynamics of mode locked fibre lasers, Northern Optics & Photonics 2015, Lappeenranta, Finland (invited talk)
- S. K. Turitsyn, “Nonlinear world of fibre lasers”, Max Planck Workshop, May 2015, Germany
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- S. K. Turitsyn, “Celebrating Solitons – 50 years of Nonlinear Science with Light”
- S. K. Turitsyn, ACP (Asia Communications and Photonics Conference) 2015, November 2015, Hong Kong
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Peer Reviewed National conferences:


“Multimodality in photo-diagnostics: dealing with human complexity” Midlands Innovation Photonics Event at Aston University, Birmingham, UK


“Modern Photonics Technologies for Multimodal Medical Diagnostics: the Way towards Personalised Medicine “Photonics meets Biology” Summer School Crete, Greece