We have come a long way since 1991, when the Photonics Research Group was founded, and even since 2011, when AiPT was established, to where we are now. We have grown and matured, haven’t we? It is interesting what will become of this place and our institute in 20 years’ time. However, an even more important question is: what is next for AiPT? The period of “Sturm und Drang” for AiPT, when we tried to explore the limits of our possible growth, and we tripled our scale, came to an end. That was fun, but we always knew we cannot grow infinitely. Optimal scale in nature (some call it size) is important for survival and the joy of living. On the one hand, it is important to have a critical mass to be able to do things; on the other hand, as we know from physics, it is harder to make large objects coherent. Large objects are more prone to various instabilities. Large objects are more likely to lose inter-coherence and flexibility, an ability to adapt to a changing environment. “Dinosaurs got it wrong”. We enter a new period for AiPT, where we will see if we can operate sustainably at this level - let me call it Lagom time. This is a Swedish word for not too big, not too small (not sure where I got it from, perhaps too many Viking series during lockdown). Our Swedish friends and collaborators might correct me, if they will ever read this column, but I think that Lagom means just the right amount, something in balance, suitable.

We are at the scale now where our impact is noticeable. It is not easy to keep the same enthusiasm when undertaking the same challenges. We try to find some balance by venturing into new areas. In AiPT, we have recently begun a new endeavour – research on applications of photonics in food industry and agri-tech. I hope we will adjust to this new stage and will demonstrate sustainability of our model. I am elated that AiPT has so many bright, younger researchers have been awarded The Royal Academy of Engineering fellowships – Maria Chernysheva, Maria Sorokina, and the third will be revealed when this report is published and the embargo on making the announcement will be lifted. Maria Sorokina did not stop and won, in the same year, the Royal Academy of Engineering Young Engineer award.

We are at the scale now where our impact is noticeable.
Academic Staff:
Prof. Sergei K. Turitsyn
Prof. Keith Blow
Prof. Andrew Ellis
Prof. Wladek Forysiak
Prof. Kate Sugden
Prof. Misha Sumetsky
Prof. Edik Rafailov
Prof. David Webb
Prof. Lin Zhang
Assoc. Prof. Sergey Sergeyev
Dr. Natalia Bezina
Dr. Berenice Bignold
Dr. Nick Doran
Dr. Vladimir Mezentsev
Dr. Ian Phillips
Dr. Alex Roblin
Dr. Sarvarree Raguthese
Dr. Elena Turitsyna
Dr. Petia Lukito
Dr. John Williams
Dr. Kamrii Zhao
Dr. Xenow Shu

Research Staff:
Dr. Paul Semret
Dr. Benson David
Dr. Nicole Chichek
Dr. Reghan Hamidabadi- Moragheh
Dr. Manuel Osorio
Dr. Riccardo De Bora
Dr. Eniko De Marco
Dr. Vadim Enyunt
Dr. Alexandre Galarbe
Dr. Vladimir Gostjuk
Dr. Bjørn Kes
Dr. Qing Li
Dr. Zhiping Liu
Dr. Ayd Moradnejad
Dr. Malgorzata Kamelion kayakip
Dr. Asma Khendi
Dr. Gwee-Khaw Koh
Dr. Laura Krichevska
Dr. Saimir Krychaj
Dr. Ege Mekesynich
Dr. Nida Khorshid Meena
Dr. Muhammad Rehman
Dr. Tran Th Ngoc
Dr. Vladimir Deputo
Dr. Maroua Tlematova
Dr. Aiko Prange
Dr. Yuryd Prykupsky

Research Students:
Mr. Abdulshuk A. Ilu
Mr. Mike Anderson
Mr. Permaan Bello
Ms. Pey cartoon Cheng
Mr. Alejandro Conde
Mr. Pedro Freire
Mr. Sebastiao Gaivao
Dr. Aaron Geiger
Mr. Mariana Gokalce
Mr. Mohammad Hossein
Mr. Mohammad Al Khateeb
Mr. Igor Kudeln
Dr. Yong Wang
Mr. Mohammed Khame
Mr. Farhad Mocht
Mr. Tying Zhang
Dr. Fang Bao

Professional Staff:
Dr. Kirill Tokmakov
Dr. Valentina Barker
Dr. Martina Pasini
Dr. Felicita Tramontana
Ms. Swaroopa Muchelisudhakar
Ms. Christiane Doering-Saad
Ms. Gosia Dzierdzikowska
Ms. Tetyana Gordienko
Mr. Martin Grant
Ms. Tatiana Kilina
Ms. Adriana Svetozarova
Ms. Janet Hull

AiPT Members
AiPT Members
Dr. Petro Lutsyk

Petro completed his PhD at the Institute of Physics, National Academy of Sciences of Ukraine (2008, Kyiv), and before joining the AIP in 2015 he contributed to several research projects (NATAS, P-4, -5, NATO Science for Peace and Security, working in Poland, Italy, and the UK). Participation in the above diverse projects allowed him to gain broad experience in design, fabrication and characterisation of novel elements of organic and inorganic electronics, photonics, optoelectronics, sensors and systems, and application of nanomaterials. The diversity of Petro’s research is evidenced by 42 peer-reviewed scientific articles in high-quality international journals, among them key papers on the development of new organic macromolecular complexes, such as carbon nanomaterials functionalised by organic molecules, for rapid detection of hazardous industrial polluters. As an outcome of the project, he characterised and optimised a range of novel organic molecules and thin-film devices shown as photonic and electronic functionalised arrays. His scientific background and current research interests embrace broad areas of nanotechnology with International networking and academic-industry collaboration experiences. All this helped him to establish broad independent research collaborations around the globe.

Dr. Srikanth Sugavanam

Srikanth is an early-career researcher fellow with AIP. He has a BSc in Physics, and a BSc in Optics and Photonics from the University of Calcutta. He is an Eurescal Mundus OptiTech scholarship recipient, with MS degrees in Photonics (EM-OptiTech) from the Warsaw University of Technology, Poland and Friedrich Schiller University, Jena, Germany under the Eurescal Mundus OptiTech programme.

Srikanth joined AIP as a PhD student under Prof. Sergei Turitsyn, specialising in real-time intensity and spectral measurement techniques to enable single-shot Nonlinear Fourier Transform (NFT)-based analysis of fibre lasers. Srikanth’s contributions have appeared in several international journals. He is, at present, collaborating with the Leibniz Institute of Photonics (IPHT), supervising a PhD student inspired by his research. Apart from actively pursuing research, Srikanth is fulfilling the role of Programme Manager for the Marie S.-Curie Fellowships Programme, MAESTROC, co-ordinated by AIP. Currently running in its third year, the programme consists of a consortium of more than 50 premier photonics research institutes worldwide, offering Marie S.-Curie Fellowships to aspiring postdocs to pursue research in areas of photonics of their choice, with a host of their choice. As part of this responsibilities, he has organised several workshops, including the landmark Machine Learning with Photonics workshop, ML -Photonica 2019. Srikanth is a certified teacher at the higher education level (Fellow of the HEA, UK). He hopes to use research-inspired teaching methodologies to train the next generation of interdisciplinary photonics scientists.

You can find out more about his research and interests at www.srikanthsugavanam.com

Main Publications


Srikanta specialises in real-time intensity and spectral measurements of fibre laser dynamics.

You can find out more about his research and interests at www.srikanthsugavanam.com

Researchers Focus

Elena has been associated with Aston University since October 2000 when she joined, as a Research Assistant, the Photonics Research Group, which has since become APT. Elena has a Master's degree in Mathematics from Novosibirsk State University in Russia, and there was a long break due to family circumstances looking after her four children before she returned to research. She was advised by the Head of Group Prof. Bennion to complete her PhD in Photonics, which she completed in 2007 with a specialty in numerical modeling of advanced fiber Bragg gratings.

In 2008 she was awarded a prestigious Royal Society Dorothy Hodgkin Research Fellowship to carry out research on optical turbulence in long fibre lasers. This led to a publication in Nature Photonics, one of the most prestigious scientific journals in the field of Photonics. Elena’s research interests are in numerical modeling of fiber laser systems and advanced fiber Bragg gratings. Recently, together with S. Sergeyev and P. Turitsyn, and researchers from Aston Brain Centre, she was involved in research on studying rogue waves in the brain that, potentially, could help in treating patients with epilepsy.

In 2012 Elena became a Lecturer, then, in 2016, a Senior Lecturer, in the Electrotechnology Engineering department. She is a Senior Fellow of the Higher Education Academy. During her 20 years’ service at Aston University, she has taught students various programming languages, staff-aware courses, and information technology. Since 2016, she is the Programme Director of the MSc in Photonics in the department of Electrical, Electronic and Power Engineering.

Elena is an active reviewer of many journals, an author of several patents, a supervisor of PhD students, and has been an invited speaker at conferences in the UK and internationally. Elena is a Senior Fellow of the Higher Education Academy and has received a number of awards for her teaching and research. These include a Teaching Excellence Award, a Staff Recognition Award, and an Award for Teaching Excellence in the University of Aston.

Elena’s current research interests include: numerical simulation of fiber laser systems; advanced fiber Bragg gratings; optical turbulence in long fiber lasers; rogue waves in the brain; and the Hurst exponent as a potential for presurgical mapping in epilepsy.

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AiPT Highlights

The last few years have been highly productive and successful for the institute across several large projects, grants, prestigious awards to AiPT members, and seminars and establishements of new collaborations. All these events contribute to further advances of AiPT research, development of new technologies and overall impact.

AiPT's Highlights

AiPT has been awarded a highly competitive and prestigious H2020 project ITN Wideband Optical Networking (WONET), co-coordinated by Prof. Wladek Forysiak (PI). The consortium consists of 14 partners, with a total award of €792,000, and involves such industrial partners as Bittium, Fujitsu, Huawei, Ericsson, Nokia, PTI, TOA, and Tyndall. This project will evaluate application of new techniques in the area of nanoelectronics (use of nanotechnology in electronics) and position him for competitive larger awards from other funders.

AiPT has been awarded one of the most competitive and prestigious H2020 projects on “Novel Pathways on Solution-Processing Carbon Nanotube Transistors for Low-Power Electronics” (Novel Pathways on Solution-Processing Carbon Nanotube Transistors for Low-Power Electronics) worth €150k. The project aims to develop new technologies for the post-digital era, when digital computational and communication technologies will reach their power limits.

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Outstanding Publications:

Dr. Srikanth Sugavanam

AiPT researchers Dr. Srikanth Sugavanam, Dr. Morteza Kamalian Kopae, Dr. Jaroslav Prilepskiy and Prof. Sergei Turitsyn, along with Dr. Jianzhu Peng from the Fudan Laboratory of Nonlinear Spectroscopy, East China Normal University, China, have co-authored a paper titled “Analysis of laser radiation using the Nonlinear Fourier transform” in the premier multidisciplinary research journal Nature Communications.

Dr. Kim F. Ferrera

Dr. Kim F. Ferrera, Prof. S. Sagatya, Prof. A. S. Bhole and Prof. M. J. Duran published an invited paper in the Journal of Lightwave Technology entitled “On the Performance of Digital Back Propagation in Spatiotemporal Multiplexing Systems”. The paper detailed several approaches to compensating nonlinearity in highly multiplexed systems such as free-space systems, demonstrating that despite random coupling, appropriately selected approaches can yield significant performance gains.

Dr. Srikanth Sugavanam

Dr. Srikanth Sugavanam has published a paper in collaboration with Dr. Maria Chernysheva, Leibniz Institute of Photonic Technologies (IPHT), Jena, Germany, titled “Real-time observation of the optical Sagnac effect in ultrafast bidirectional fibre lasers”. The paper demonstrates how the Sagnac effect arising in such lasers can be visualised in experiments and be used to make precise high-speed gyroscopic measurements.

Dr. Arno Pernsteiner

Dr. Arno Pernsteiner had a paper published in January 2020 in Nature Communications (Impact Factor 13.13, Rank: 4/69 Multidisciplinary Sciences) titled “Breathing dissipative solitons in mode-locked fibre lasers.” The work was done in collaboration with researchers from the East China Normal University in Shanghai, China.

Dr. F. M. Ferreira

Dr. F. M. Ferreira, along with Prof. Sergei Turitsyn, Prof. N. J. Doran and Prof. A. D. Ellis published an invited paper in Science Advances (Impact Factor = 12.804, Rank: 4/69 Multidisciplinary Sciences) titled “Analysis of laser radiation using the Nonlinear Fourier transform” in the premier interdisciplinary research journal Nature Communications.

Dr. Auro Perego

Dr. Auro Perego had a paper published in January 2020 in Nature Communications (Impact Factor 13.13, Rank: 4/69 Multidisciplinary Sciences) titled “Coherent master equation for laser mode-locking”. This work is the result of research performed in the framework of an international collaboration with Université de Nice (France), Università degli Studi dell’Insubria (Italy) and Universitat de València (Spain). We have established a novel theoretical framework (Coherent Framework) for the description of light pulses (mode-locking) in lasers and validated our model experimentally.

Prof. Andrew Ellis

Prof. Andrew Ellis contributed to an article published in April 2019 in Nature Photonics (Impact Factor of 12.566) entitled “Facilitated Atomic Atomic Antenna”. The contribution was the result of a collaborative workshop investigating sustainable photonic solutions to providing internet connectivity in sub-Saharan Africa, containing a roadmap highlighting as evolution from rapidly expanding free-space optical solutions towards robust high-capacity optical fibre networks.

Prof. Sergei Turitsyn

Prof. Sergei Turitsyn was invited to join the programme Dispersive hydrodynamics: mathematics, simulation and experiments, with applications in nonlinear waves (2019 – 2020) at the Isaac Newton Institute for Mathematical Sciences in Cambridge. The programme is designed to encourage interactions amongst mathematicians, physicists and engineers operating in the analysis of dispersive nonlinear wave experiments and numerical evaluation.

In 2019 researchers from Aston University published 21 papers at the premier optical communications conferences, Optical Fibre Communications, and European Conference on Optical Communications.

The submissions span a wide range of topics, including the nonlinear Fourier transform, digital signal processing, optical phase conjugation and ultra-broadband amplification.

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AFT Highlights

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AFT team at CLEO 2019, June 2019, Munich, Germany

CLEO 2019

AFT co-organized the 46th European Conference on Optical Communications, CLEO 2019, that took place in Dublin in September 2019. Prof. Andrew Ellis acted as the technical programme committee chair. The event included a well-attended public outreach event headlined by Prof. Bilal Cox, over 240 scientific presentations, a well-received all-electronic poster session, and two directly focused events where the high level of participation of female speakers in sub-committees (50%); plenary (48%) and invited (46%) presentations was ranked. AFT was a sponsor of the Conference Gala dinner. 16 AFT members attended CLEO 2019 in Dublin and presented their scientific work and research results.

EOOC 2019

AFT co-organized the 47th European Conference on Optical Communications, EOOC 2019, that took place in Lisbon in September 2019. Prof. Andrew Ellis acted as the technical programme committee chair. The event included a well-attended public outreach event headlined by Prof. Bilal Cox, over 240 scientific presentations, a well-received all-electronic poster session, and two directly focused events where the high level of participation of female speakers in sub-committees (50%); plenary (48%) and invited (46%) presentations was ranked. AFT was a sponsor of the Conference Gala dinner. 16 AFT members attended EOOC 2019 in Dublin and presented their scientific work and research results.
V Summer School “Photonics meets Biology”
16th – 20th September 2019. Venue: FORTH, Heraklion, Crete, Greece
Prof. E. Rafailov is organiser of this summer school.

OFC 2020
Six members of AiPT travelled to San Diego, USA in early March for OFC 2020, the largest global academic and industry conference in the field of optical fibre communications, with four AiPT researchers attending virtually. While the conference exhibition was impacted heavily by the coronavirus pandemic, over 90% of the originally planned conference papers were delivered, either in person or via Zoom. AiPT presented a total of nine invited oral and poster papers, while Prof. Forysiak acted as chair for five sessions as sub-committee chair in Fibre and Propagation Physics.

Workshop at Anacapri
AiPT members attended the Workshop on Nonlinear Optical Frequency Combs: Dynamics and Applications in October 2019 that took place in Anacapri, Italy. Nonlinear resonators are an attractive platform for generation of optical frequency combs, light sources whose spectrum is a discrete array of equally-spaced narrow laser lines. In the last decade, both second- and third-order nonlinearities have been exploited to generate frequency comb, providing an intriguing alternative to traditional mode-locked lasers. The workshop aimed at presenting and discussing ideas on the latest developments in the physics of frequency combs in nonlinear resonators, through a series of lectures from world-leading experts in the field. The workshop was the first training event for PhD students of H2020 EID MOCCA, a European Industrial Doctorate project, coordinated by Aston.

Honours and Awards to AiPT Members
In 2018 AiPT Profs. Nick Doran and Andrew Ellis were elected one of the most prestigious honour for researchers in photonics – Fellowship of the Optical Society of America. Nick was elected for technical leadership in nonlinear fibre transmission and switches including amplifiers and switches, and pioneering contributions to soliton transmission and processing. Andrew received this honour for pioneering contributions in the areas of all-optical signal processing and mitigation of fibre and nonlinear transmission impairments.
In 2019 one more AiPT member, Prof. Lin Zhang, was elected to the Fellowship of the Optical Society of America. This was awarded to technical leadership and outstanding contributions to the research and development of ultrafast nonlinear optical fibre devices and applications in optical communications and sensing.

Professor Sergei Turitsyn has been appointed Associate Editor of the Journal of Lightwave Technology, that is internationally recognised as one of the leading journals in the field of optical communications, co-sponsored by seven IEEE technical societies and the Optical Society of America, and receives more than 6000 citations per year, from integrated photonics to optical networks.

Dr. Mariia Sorokina was announced as one of the five young leaders in engineering of SPIE, the world’s largest optical science and technology society, and winner of the Year competition, awarded by the RAEng Academy with support from the Worshipful Company of Engineers. Maria has developed a novel type of signal shaping that breaks the established paradigm, for the first time enabling fibre-optic communication faster than was previously thought possible. This discovery is seen as crucial for the development of future high-capacity broadband systems to meet the ever-increasing demand for data.

AiPT team at OFC 2020
AiPT members at the Workshop on Nonlinear Optical Frequency Combs: Dynamics and Applications, Anacapri, Italy
Optical Communications

The capacity of our communication network continues to be a major concern, especially in the first half of 2020, where the response to COVID-19 has tested the capabilities of the network in response to a rapid switch towards home working. The pressure is felt across a wide range of areas of specialism, ranging from hardware issues such as the total volume of information passing through a single optical fibre, the cost of access networks to connect with end users, or the maximum potential bit rate of a wireless link, through software, such as the stability of the Internet Protocol, to political issues such as the future of net-neutrality with governments requesting that video content providers restrict the bandwidths of their streams in response to the crisis.

AiPT continues to perform research addressing fundamental issues across the network, ranging from increasing the available resources through record 150nm amplification bandwidths, enhancement of access networks by the addition of fundamentally burst-mode-compatible optical amplifiers, reduced costs through advances in transponder technology, and increased network robustness by compensating for power-dependent signal distortion induced by optical fibre themselves. Recently, we have won bids to study the use of free-space optics to simultaneously dramatic increase connection bandwidths to the home and reduce the installation cost and to develop systems employing purely optical signal processing to perform critical network functions.

Whilst the team at Aston continues to push back the known limits to provide even greater capacities (see publications) the UK government continues to prioritise the deployment of fibre-backed technologies capable of Gbit/s connection speeds such as “pure fibre” and “fibre to the pole”, and the deployment of 5G networks, where each antenna is connected to the network by fibre, continues to grow.

In recent years, optical amplifiers have become a key component in modern optical communication systems. They enable the transmission of data over long distances with minimal signal degradation. However, one of the key challenges for realizing future ultra-wideband optical transmission systems is the nonlinear distortion of the transmitted signals.

One of the key challenges for realizing future ultra-wideband optical transmission systems is the nonlinear distortion of the transmitted signals. This is because the signals are typically transmitted at very high power levels, which can lead to nonlinear effects such as self-phase modulation (SPM) and cross-phase modulation (XPM). These nonlinear effects can cause significant degradation of the transmitted signal, leading to distortions in the data being transmitted.

To overcome these nonlinear effects, researchers have proposed the use of dual-stage Raman amplification schemes. In these schemes, two Raman amplifiers are used to amplify the signal, with one amplifier placed before the other. This allows for the nonlinear effects to be mitigated, as the first amplifier can compensate for the nonlinear effects introduced by the second amplifier.

One of the key advantages of this approach is that it can be used to amplify signals over long distances without the need for electrical regenerators. This makes it a highly effective technique for applications such as long-haul optical communication systems.

In this paper, we present the results of our experiments demonstrating the effectiveness of this approach. We show that by using dual-stage Raman amplification, we can significantly reduce the nonlinear distortions of the transmitted signals, allowing for high-quality transmission over long distances.

Our results indicate that dual-stage Raman amplification is a highly effective technique for reducing nonlinear effects in optical communication systems. We believe that this approach will play a key role in the future development of ultra-wideband optical transmission systems.
Optical Sensing

The Photonics Research Group at Aston University (precursor to AiPT) was one of the first groups to begin developing the technology of fibre gratings back in the early 90s, which in turn led to extremely fruitful research into the development of fibre grating sensors. Even today, research continues on grating sensors, investigating in different kinds of fibre (polymer, multi-core and photonic crystal fibres) and opening up new application areas for example, fuel monitoring in the aerospace industry. As such, our sensing related work has broadened beyond fibre grating sensors.

The sensing and devices group members have had to meet virtually during the coronavirus pandemic and our research continues.

- Work on optical coherence tomographic (OCT) imaging has led to a commercial system that can produce real-time, 3D images of flexible contact lenses as well as a C02 ablation target for OCT imaging systems, manufactured using one of AiPT’s patented laser micro-machining systems.

- Progress in semiconductor laser technology has allowed us to develop low-cost tunable diode laser spectroscopy systems.

- Graphene oxide has been used as an efficient, low-cost humidity sensor. We have developed novel and highly effective approaches to early detection of such devices, which rely on the inherent coherence length of the source. This programme is supported by EPSRC. New research is investigating the use of graphene oxide to develop novel, low-cost humidity sensors. This work has been ongoing for a few years. This programme is supported by EPSRC.

- A programme of investigating laser detection through the detection of coherence has been ongoing for a few years. The principle of laser detection involves observing coherence at the individual photon level — the coherence length of the laser determines the effective coherence length of the source. This programme is supported by DSTL who are sponsoring a PhD student looking at laser detection of coherence.

- We have a major effort underway, developing photonic technologies in the agri-tech and agri-food sectors. Topics include increasing the amount of citrus and mango fruits on the market, the development of a low-cost multiphoton imaging system for food quality monitoring and the creation of an optical fibre-based system capable of the real-time detection of contaminants in a bakery.

- Progress in sensor and device technology has allowed us to develop low-cost tunable diode laser spectroscopy systems.

- The detection of coherence has been ongoing for a few years. This programme is supported by EPSRC. New research is investigating the use of graphene oxide to develop novel, low-cost humidity sensors. This work has been ongoing for a few years. This programme is supported by EPSRC.

Key Research Areas

Academic staff:

Research fellows:
- Dr. Daniel Jiang
- Dr. Adenowo Gbadebo

Research students:
- Ms. Yang Lu
- Ms. Shengying Gao

Visitors:
- Dr. Yidong Tan
- Dr. Vladimir Osipov
- Dr. Daniel Hill

Combined soil sample incorporating fibre optic moisture sensor

Dr. Fred Pressler from the University of Calgary working on fibre optic moisture sensors.
Nonlinear Photonics and Fibre Lasers

The Nonlinear Photonics and Fibre Lasers team pursues cutting-edge fundamental and applied research in a diverse range of topics, including temporal nonlinear effects, ultrafast processes, ultrafast fibre laser sources, solitons, frequency combs, dissipative structures and optical communications. A major 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, as well as the new applications already made possible by the nonlinear fibre-optic technology.

AiPT research in the field of neuromorphic photonics is supported by the recently awarded European Training Network POSTDIGITAL, coordinated by AiPT (https://postdigital.astonphotonics.uk/), with 13 partners including IBM, Thales and SMEs LightOn, VLC Photonics and IniLabs. Understanding the fundamental physics behind laser generation in nonlinear fibre resonators is critically important for the development of novel high-performance laser sources offering turn-key solutions for various practical applications. By unraveling the origin of new types of unique states of polarisation evolving on very complex trajectories, our research paves the way to new techniques in metrology, high-resolution femtosecond spectroscopy, high-speed and secure fibre optic communications, nano-optics (trapping and manipulation of nanoparticles and atoms), and spintronics (vector control of magnetisation).

An example of our application-focused research is advancing LIDAR technologies able to complement the distance ranging by an additional functionality – recognition of the target texture – by using mode-locked fibre lasers with dynamic states of polarisation. AiPT has filed a patent application on this novel idea for LIDAR and radar for autonomous driving. The UK companies RDM Group and Highways England already expressed interest to joint development of the new generation of LIDARs. This technique proposed in AiPT will be further developed in H2020 Innovative Training Networks MOCCA (https://mocca.astonphotonics.uk/) and MEFISTA, coordinated by AiPT, with industrial partners including Thales, WITec, NKT Photonics, Thales, III-V Labs, AMO, RDM and AMI Photonic.

Grants and Awards (awarded or ongoing) 2018 – 2019

- H2020 MSCA COFUND
- The Royal Society Newton Advanced Fellowship
- The Leverhulme Trust Research project: "Nonlinear coherent system and geometric approach in optical communications"
- The Leverhulme Trust Visiting Professorship: "Nonlinear fibre optics: fibre lasers and sensors"
- British Council Newton project with Indonesia
- The Royal Society Global Challenges collaborative project: "H2020 MSCA ETN FOSTER/DIG/17"
- "H2020 MSCA ETN MEFISTA"
- "H2020 MSCA ETN MOCCA"
- "H2020 MSC Fellowship: ProDigi"
- "H2020 MSC Fellowship: RANPOFIL"
- "H2020 MSC Fellowship: Photonic Radar"

Academic Staff:

- Prof. Sergei Turitsyn
- Assoc. Prof. Sergey Sergeyev
- Dr. Sonia Boscolo

Research Fellows:

- Dr. Vladislav Dvoyrin
- Dr. Morteza Kamalian-Kopae
- Dr. Hani Kbashi
- Dr. Egor Manuylovich
- Dr. Auro Michele Perego
- Dr. Yaroslav Prylepskiy
- Dr. Vishal Sharma
- Dr. Srikanth Sugavanam
- Dr. Marina Zajinulina

Research Students:

- Mr. Alexander Donodin
- Mr. Igor Kudelin
- Ms. Anastasiia Vassyl

Visiting Professor:

- Prof. Andrea Rofaili
Breathing dissipative solitons in an ultrastable fibre laser


Physical systems. Our findings are accessible by solely changing the pump strength. Besides, for the first time in experiments with normal-dispersion regime of the laser cavity breathers are excited in the laser under the pump threshold for stationary mode locking. Our work first establishes a general, deterministic route to induce soliton breathing in normal-dispersion fibre cavities in that the breather generation regime of continuous wave RLGs. Instead of using traditional averaged approaches of measurement, we used real-time intensity and spectral measurement techniques for spatio-temporal dynamics and analysis of coherent structures embedded into dispersive radiation. We used full field, real-time experimental measurements of incoherent pulses to compute the nonlinear pulse spectra. For the classification of breather regimes, we presented the concept of eigenvalue probability distributions. In addition, we presented two-field normalisation approaches and showed the NFT can yield as effective model of the laser radiation under appropriate signal-normalisation conditions. The full field information made available by the experimental methodology, together with the information about the nonlinear content provided by the NFT, can improve our understanding of the underlying dynamics in a wide range of lasers, and nonlinear systems in general.


Analysis of Laser Radiation Using the Nonlinear Fourier Transform

Modern high-power lasers exhibit a rich diversity of nonlinear dynamics, often featuring nonlinear characteristics that both extend beyond the conventional scope of linear properties. While the classical Fourier method adequately describes extended dispersive waves, the analysis of stationary signals call for more nuanced approaches. Yet, mathematical methods for simultaneous characterisation of localised and extended fields are not well developed. In our work published in Nature Communications, we demonstrated how the Nonlinear Fourier Transform (NFT) based on the Zakharov-Shabat spectral problem can be applied as a signal processing tool for representation and analysis of coherent structures embedded into dispersive radiation. We used full-field, real-time experimental measurements of incoherent pulses to compute the nonlinear pulse spectra. For the classification of breather regimes, we presented the concept of eigenvalue probability distributions. In addition, we presented two-field normalisation approaches and showed the NFT can yield an effective model of the laser radiation under appropriate signal-normalisation conditions. The full field information made available by the experimental methodology, together with the information about the nonlinear content provided by the NFT, can improve our understanding of the underlying dynamics in a wide range of lasers, and nonlinear systems in general.


Bidirectional Ultrafast Lasers for Gyroscopic Measurements

Active ring laser gyroscopes (RLG) operating on the principle of the optical Sagnac effect are used in a range of applications, such as inertial guidance systems, seismology and geodesy, in which the requirement for high angular stability and high angular velocity resolution. Operating at such angular accuracy levels demands special precautions like dithering or multi-mode operation to eliminate frequency lock-in or similar effects introduced due to synchronisation of counter-propagating channels. In our work, we showed how bidirectional ultrafast fibre lasers can be applied as signal processing tools for the detection of continuous wave RLGs. Instead of using traditional averaged approaches of measurement, we used real-time intensity and spectral measurement techniques for spatio-temporal dynamics and analysis of coherent structures embedded into dispersive radiation. We used full-field, real-time experimental measurements of incoherent laser pulses to compute the nonlinear pulse spectra. For the classification of breather regimes, we presented the concept of eigenvalue probability distributions. In addition, we presented two-field normalisation approaches and showed the NFT can yield as effective model of the laser radiation under appropriate signal-normalisation conditions. The full field information made available by the experimental methodology, together with the information about the nonlinear content provided by the NFT, can improve our understanding of the underlying dynamics in a wide range of lasers, and nonlinear systems in general.


Visualisation of Extreme-Value Events in Optical Communications

Fluctuations of temporal signal propagating along long haul transoceanic-scale fibre links can be visualized in the spatio-temporal domain, showing visual analogy with ocean waves. Substantial deviations of local peak power from average signal power levels can be observed in the output of high-power optical fibre lasers and amplifiers. These deviations of local peak power from average signal power levels can be caused by extreme value fluctuations, which is a nontrivial problem of high peak to average power ratios. In such systems, the output signal may feature, for example, noise spikes, arising from amplified spontaneous emission spikes which can cause severe degradation of transmitted coherence. We applied the well-established concept of adaptive wave visualisation in the spatio-temporal domain, drawing visual analogy with ocean waves. Substantial fluctuations of temporal signal propagating along long haul transoceanic-scale fibre links can be visualized in the spatio-temporal domain, showing visual analogy with ocean waves. Substantial deviations of local peak power from average signal power levels can be observed in the output of high-power optical fibre lasers and amplifiers. These deviations of local peak power from average signal power levels can be caused by extreme value fluctuations, which is a nontrivial problem of high peak to average power ratios. In such systems, the output signal may feature, for example, noise spikes, arising from amplified spontaneous emission spikes which can cause severe degradation of transmitted coherence. We applied the well-established concept of adaptive wave visualisation in the spatio-temporal domain, showing visual analogy with ocean waves.
Modern microphotonic technologies have achieved the tremendously high fabrication precision of a few nanometers. However, it has been found that this outstanding precision is still insufficient for a broad range of applications. To overcome this challenge, our group is working on the development of a new photonic technology, Surface Nanoscale Photonics (SNAP) which allows us to demonstrate miniature photonic devices with unprecedentedly high precision of fractions of an angstrom. SNAP employs optical whispering gallery modes circulating near the fibre surface and slowly propagating along its axis. The speed of propagation of these modes along the fibre axis is so slow that it can be fully controlled by dramatically small nanoscale variations of the fibre radius. Our group has developed SNAP technology for fabrication of ultraprecise, ultralow-loss, tunable, switchable and reconfigurable miniature photonic devices establishing the groundwork for their revolutionary applications in telecommunications, ultra-precise sensing, quantum computing and networking, optomechanics, optofluidics and other fields of engineering and science.

The results of our work in 2019 can be briefly summarized as follows. PhD student Gabriella Gardosi discovered the effect of slow cooking of SNAP microresonators permitting several important applications in the food industry to telecommunications and quantum technologies. This invention of the fibre radius. Our group develops the advanced SNAP technology for fabrication of ultraprecise, ultralow-loss, tuneable, switchable and reconfigurable miniature photonic devices establishing the groundwork for their revolutionary applications in telecommunications, ultraprecise sensing, quantum computing and networking, optomechanics, optofluidics and other fields of engineering and science.

Whispering-gallery-mode-induced Nanoscale Alterations at the Silica-Water Interface Create Optical Microresonators

Silica and water are known as exceptionally inert chemical materials, while the mechanics of fast interaction is still completely understood. We show that the interplay of these slow and tunnelling waves can create new phenomena not previously described. Here, we demonstrate this effect on the example of a short segment of an optical fibre coupled into silica microcapillary. The whispering gallery soliton is launched from the fibre microcavity into the fibre segment and slowly propagates along its mircron-scale length. The speed of the soliton loads and transfers microcavities into silica material. This change results in 26% local loss, tuneable, switchable and reconfigurable miniature photonic devices establishing the groundwork for their revolutionary applications in telecommunications, ultraprecise sensing, quantum computing and networking, optomechanics, optofluidics and other fields of engineering and science.

In Situ Observation of Slow and Tunnelling Light at the Optical Fibre

We show how light can be controllably transported at micron-scale distances. We design a miniature device which consists of a short segment of an optical fibre coupled into a transparent material which has demonstrated the first four-port resonant SNAP device, switched interplay between the slow and tunnelling light. Dr. Manuel Crespo-Ballesteros, who, together with Yong Yang, experimentally demonstrated the phenomenon for the first time, provided the first demonstration of SNAP microresonators having promising applications in the field of nonlinear photonic devices. Above, the discovered effect opens a way to the ultrasensitive fabrication of resonant optical microdevices as well as suggests an ultrasensitive method for the characterization of physical and chemical processes at the nanoscale.

Grants and Awards
- Horizon 2020 MC-ITN 2011-2014
- Horizon 2020 CORDIS MULTIPAY

Academic Staff:
- Ms. Gabriella Gardosi
- Mr. Sajid Zaki

Research Fellows:
- Dr. Manuel Crespo-Ballesteros
- Dr. Kirill Tokmakov
- Dr. Yong Yang

Research PhD Students:
- Mr. Sajid Zaki
- Mr. Shahrar Azad

Students:
- Research PhD
  - Ms. Gabriella Gardosi
  - Mr. Sajid Zaki
  - Mr. Shahrar Azad

Research Fellows:
- Prof. Misha Sumetsky
- Dr. Nikita Toropov

Students:
- Research PhD
  - Mr. Sajid Zaki
  - Mr. Shahrar Azad

Grants and Awards
- Horizon 2020 MC-ITN 2011-2014
- Horizon 2020 CORDIS MULTIPAY

Funding:
- Wolfson Foundation (£500k), Grant 22069
- EPSRC SNAP (£916k)

Maha-Weidenmüller Approach to Cavity Quantum Electrodynamics and Complete Resonant Down-Conversion in the Single-Photon Frequency

A photon is a discrete plume of quantum electromagnetic field fluctuations. Many experiments, such as single-photon interference, are performed by using a single photon in a superposition of two different states. When two photons are created by spontaneous parametric down-conversion, one photon is selected by a polarizing beam splitter and the other is considered a single-photon source. These experiments mostly rely on the creation and manipulation of single photons. A photon is a discrete plume of quantum electromagnetic field fluctuations. Many experiments, such as single-photon interference, are performed by using a single photon in a superposition of two different states. When two photons are created by spontaneous parametric down-conversion, one photon is selected by a polarizing beam splitter and the other is considered a single-photon source. These experiments mostly rely on the creation and manipulation of single photons. A photon is a discrete plume of quantum electromagnetic field fluctuations. Many experiments, such as single-photon interference, are performed by using a single photon in a superposition of two different states. When two photons are created by spontaneous parametric down-conversion, one photon is selected by a polarizing beam splitter and the other is considered a single-photon source. These experiments mostly rely on the creation and manipulation of single photons.
Nanoscience Research Group

Development of Carbon-Nanomaterials-based Saturable Absorbers and Study of Their Properties

Composites of single-walled carbon nanotubes (SWNTs) and water-soluble polymers (PS) are the focus of significant worldwide research due to a number of applications in biotechnology and electronics, particularly for artefact light generation. Despite the unique possibility of constructing non-linear optical (NLO) composite photomaterials, the study of optical properties of such materials, particularly for artefact light generation, is still ongoing. This is due to the complexity of the process, which is affected by the presence of defects, impurities, and surface contamination. For this reason, the thermal degradation and thermal stability of the photomaterials have been under continuous high-power ultrashort pulse laser bombardment.

Sensing of Ammonia by Ultrafast Thermophotovoltaics

The sensing properties of carbon nanotubes (CNTs) have been a focus of research due to their multifaceted properties, particularly for their use in ultrafast photonic devices. Our research interest is due to the multiplicity of research on CNT-based devices, particularly in the field of optoelectronics and sensing applications. Our recent research is focused on CNT-based nanomaterials with selectivity and high sensitivity for ammonia detection. Our work is based on the use of CNTs as a sensitive layer in a thermophotovoltaic device, which can be used for the detection of ammonia in real-time. The device is based on a CNT composite, which is excited by a laser and generates electrical signals that are proportional to the concentration of ammonia in the sample. The results of our research have shown that our device is highly sensitive and selective for ammonia detection, which can be used for applications in environmental monitoring, medical diagnostics, and homeland security.
The Laser and Biomedical Photonics Research Group conducts cutting-edge experimental and theoretical research on high-power and ultrashort-pulse compact lasers, enabling the visible, near-IR, mid-IR and THz spectra ranges, nanostructures, non-linear optics, integrated optical circuits and bio-photonics.

One of the major research directions is focused on the development of compact CW and ultra-fast semiconductor lasers and photonic crystals. We have achieved the highest output average power from semiconductor lasers operating at the second harmonic of the 976 nm wavelength in the indium phosphide material system in continuous wave (CW) mode of 9.1 W, and from single frequency semiconductor lasers in the mid-IR spectral range of 50 W. Another major research area involves the development of room temperature, ultra-complex and portable THz point sensors in the 0.3 – 5 THz frequency range and safety and security applications, quality control in biophotonics and medical imaging. The group has worked extensively in areas of spectral control, nonlinear and integrated optics and bio-photonics.

In close partnership with companies and organisations across Europe, we have developed new materials, we aim to improve the process of diagnosing and treating some of the most challenging conditions facing healthcare and society.

One of the major research directions is focused on the development of compact CW and ultra-fast semiconductor lasers, emitting in the visible, near-IR, mid-IR and THz spectral ranges, nanostructures, non-linear and integrated optics and bio-photonics.

In close partnership with companies and organisations across Europe, we have developed new materials, we aim to improve the process of diagnosing and treating some of the most challenging conditions facing healthcare and society.

The investigation of conical refraction optical phenomena, in which light passing through a biaxial crystal leads to an output with an unusual cone shaped intensity profile and polarisation properties, is also carried out by our group. By studying waveguide-type high-power optical and ultrashort pulse lasers and their interactions with different materials, we are able to improve the processing efficiency and lifetime of some of the most demanding conditions facing healthcare and society.

In close partnership with companies and organisations across Europe, we have developed new materials, we aim to improve the process of diagnosing and treating some of the most challenging conditions facing healthcare and society.

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In close partnership with companies and organisations across Europe, we have developed new materials, we aim to improve the process of diagnosing and treating some of the most challenging conditions facing healthcare and society.
UV lasers have long been used to make in-fibre gratings at AIT, taking advantages of photobleaching of pre-doped or boron-doped optical fibre which can be of different geometry including single mode, multimode, D-shaped and multicore fibre. AIT’s recent research on UV-inscribed fibre gratings include advanced fabrication technology, novel grating such as tilted gratings and gratings in novel optical fibre and exploitation for different applications such as fibre-optical sensing, fibre lasers and optical communication.

In this research, we used direct femtosecond inscription of photonic devices taking advantage of their ultrashort pulse duration, high peak power and thus endorsed unique interaction with matter including two-photon absorption, index modification and direct ablation. A number of UV and femtosecond lasers are available at AIT and have been used for microfabrication of fibre gratings in various nanomaterial such as UNGO, high refractive index contrast microstructure in glass material as well as polystyrene and silica. These photonic devices can be used in a very diverse range of applications including sensing, food safety, agriculture, health care and medical. A femtosecond laser has been used at the University of Manchester to create photonic devices based on optical fibre (3D optical-fibre waveguide) for the development of a novel fibre-based biomonitoring system. By combining a femtosecond laser with a photodetector, a fibre-based biomonitoring system can be created that can detect pathogens and environmental contaminants in real-time. The system is based on the principle of two-photon absorption, which allows for high spatial resolution and sensitivity. The system has been tested for the detection of bacteria and viruses, and the results have shown promising results, indicating that this technology has potential for use in various applications such as healthcare, food safety, and environmental monitoring.

Selected Publications:

- Yu, Qi, Zaki, Sajid, Yang, Yong, Toropov, Nikita, Shu, Xuewen and Sumetsky, Misha (2019). Rectangular SNAP microresonator for optical sensing, fibre lasers and optical communication. Particularly, strained LiNbO3 (S-LN) offers notable potential for use as a substitute for InGaAsP due to its wide range of tolerance, high second-order nonlinearity and commercial availability. The absorption in S-LN increases considerably with the rise of pump power, which is beneficial for the absorption of shorter wavelength laser sources (e.g., Ti:Sapphire laser) operating in the visible to near infrared. The low attenuation and high thermal resistance are prominent merits of S-LN for the development of compact and compacted fibre lasers, which are essential when testing the system and during normal use to ensure that there is no misalignment or distortion that could affect the results. The spherical layer is located at 150μm (in AD) underneath the planar surface. Due to the laser power loss when travelling through the deeper layer, an increased power is applied to the deeper layers. Here we present a new multi-purpose plano-convex OCT system. The characterisation and calibration of OCT systems is essential when testing the system and during normal use to ensure that there is no misalignment or distortion that could affect the results. The spherical layer is located at 150μm (in AD) underneath the planar surface. Due to the laser power loss when travelling through the deeper layer, an increased power is applied to the deeper layers.

- Yu, Qi, Du, Yueqing, Xu, Zuowei, Wang, Peng, Zhang, Zhen, Zhu, Zece, Cao, Haoran, Sumetsky, Michael and Shu, Xuewen (2018). Lithium niobate in electric vehicles, (Sept/2019-Aug/2021). We fabricated and optimised optical-lattice-like depressed cladding waveguides in nonlinear LiNbO3, offering improved versatility creating microstructures in the three-dimensional space. We fabricated and optimised optical-lattice-like depressed cladding waveguides in nonlinear LiNbO3, offering improved versatility creating microstructures in the three-dimensional space. We fabricated and optimised optical-lattice-like depressed cladding waveguides in nonlinear LiNbO3, offering improved versatility creating microstructures in the three-dimensional space.

Femtosecond Laser Inscribed Advanced Calibration Phantom

Femtosecond laser inscribed advanced calibration phantoms for optical coherence tomography (OCT) have been widely used in information processing and optical communication. Particularly, strained LiNbO3 (S-LN) offers notable potential for use as a substitute for InGaAsP due to its wide range of tolerance, high second-order nonlinearity and commercial availability. The absorption in S-LN increases considerably with the rise of pump power, which is beneficial for the absorption of shorter wavelength laser sources (e.g., Ti:Sapphire laser) operating in the visible to near infrared. The low attenuation and high thermal resistance are prominent merits of S-LN for the development of compact and compacted fibre lasers, which are essential when testing the system and during normal use to ensure that there is no misalignment or distortion that could affect the results.

UV Inscription of Tilted Fiber Grating

AIT developed tilted fiber grating (TFG) technology, a type of fiber-grating device which can couple light to cladding modes and radiation modes, preventing unique optical properties depending on the fiber type, and exploited them for many applications, including optical film sensing and fiber laser. The large-angle TFG, creating light to cladding modes which possess a higher dispersion of research values, lower higher sensitivity to external vibration and lower has been used for biosensing recently. In this research, we used direct femtosecond inscription of photonic devices taking advantage of their ultrashort pulse duration, high peak power and thus endorsed unique interaction with matter including two-photon absorption, index modification and direct ablation. A number of UV and femtosecond lasers are available at AIT and have been used for microfabrication of fibre gratings in various nanomaterial such as UNGO, high refractive index contrast microstructure in glass material as well as polystyrene and silica. These photonic devices can be used in a very diverse range of applications including sensing, food safety, agriculture, health care and medical. A femtosecond laser has been used at the University of Manchester to create photonic devices based on optical fibre (3D optical-fibre waveguide) for the development of a novel fibre-based biomonitoring system. By combining a femtosecond laser with a photodetector, a fibre-based biomonitoring system can be created that can detect pathogens and environmental contaminants in real-time. The system is based on the principle of two-photon absorption, which allows for high spatial resolution and sensitivity. The system has been tested for the detection of bacteria and viruses, and the results have shown promising results, indicating that this technology has potential for use in various applications such as healthcare, food safety, and environmental monitoring.

The spherical layer is located at 150μm (in AD) underneath the planar surface. Due to the laser power loss when travelling through the deeper layer, an increased power is applied to the deeper layers. Here we present a new multi-purpose plano-convex OCT system. The characterisation and calibration of OCT systems is essential when testing the system and during normal use to ensure that there is no misalignment or distortion that could affect the results. The spherical layer is located at 150μm (in AD) underneath the planar surface. Due to the laser power loss when travelling through the deeper layer, an increased power is applied to the deeper layers.
Two photon polymerisation

Multiphoton direct writing is a photonic technology which is based on femtosecond laser pulses application and enables the fabrication of any designed 3D micro-devices with features on submicron-relevant length scales (i.e. 100nm-scale precision). This unique method is used for additive manufacturing of polymer-based micro-optical and micro-fluidic elements with free-form 3D topographies that may be utilised for the development of precise, micro-based and cost-effective micro-sensors.

Original setup for multiphoton lithography (based on the Chromacity femtosecond laser) has been designed and assembled at AiPT to fabricate micro-optical elements directly at the end-face of optical fibres. Combination of the mature technology of fibre optics and high potential of modern nanophotonics will offer new horizons in fabrication of low-cost and high precision sensors. It is planned to design novel fibre-edge based gas sensors and fabricate them using a combination of 2PP lithography and femtosecond laser processing. We will apply the technique of femtosecond laser structuring of photosensitive materials recently developed at Aston to a variety of acrylate and epoxy materials to develop fibre-based gas sensors (for CO2, CH4, NH3, other gases). Direct 3D laser writing will provide us with many interesting possibilities for the design of novel optical systems and efficient light transformations. The new techniques for the flexible manufacturing of micro-optical and microfluidic elements for innovative devices and systems will be of wider interest in gas diagnostics research beyond food, agri-tech and biomedical applications.

Micro/Nano Surface Showing Wettability

A surface can be irradiated with femtosecond laser microfabrication and depending on the processing parameters, the surface can show unique features like nanostructures and nanospikes. It’s these surface nanostructures that entail unique physical properties including the wettability and much reduced reflection. Femtosecond lasers are capable of processing a variety of materials including metals, semiconductors and dielectrics like glass and ceramics, giving rise to a superhydrophobic surface, which repels water, or a superhydrophilic surface which spreads the water droplet to the maximised area. Both effects are very useful for industrial applications; the superhydrophobic surface can be used for self-clean surface while the superhydrophilic surface can potentially be used for removing oil.

In collaboration with a regional company, the surface of stainless steel was processed with a femtosecond laser at AiPT, and certain hydrophilic behaviour was demonstrated.
Research Portfolio

In the Horizon 2020 actions, Aston University is collaborating with over 500 organisations and participates in over 90 projects. Within Aston, AiPT is the UK’s most successful coordinator of H2020 Initial Training Networks and 5th in Europe, surpassing many pan-national organisations.

AiPT grants in 2018/2020

2018 - 2020 have been very productive and successful years for our institute, proving that AiPT is a centre of excellence in photonics with global international visibility and a reputation as a trailblazer in research and innovation. We have valuable experience in formulating successful funding proposals and supervising and administering a diverse range of projects covering research, industrial collaboration and training.

<table>
<thead>
<tr>
<th>Funder</th>
<th>No. of Awards</th>
<th>Total award value for AiPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUROPEAN COMMISSION</td>
<td>31</td>
<td>13,004,932</td>
</tr>
<tr>
<td>EPSRC</td>
<td>12</td>
<td>8,814,304</td>
</tr>
<tr>
<td>UK GOVERNMENT</td>
<td>4</td>
<td>2,583,689</td>
</tr>
<tr>
<td>THE ROYAL ACADEMY OF ENGINEERING</td>
<td>5</td>
<td>1,071,760</td>
</tr>
<tr>
<td>INDUSTRIAL PROJECTS</td>
<td>11</td>
<td>871,057</td>
</tr>
<tr>
<td>THE WOLFSON FOUNDATION</td>
<td>1</td>
<td>933,000</td>
</tr>
<tr>
<td>THE LEVERHULME TRUST</td>
<td>1</td>
<td>419,309</td>
</tr>
<tr>
<td>THE ROYAL SOCIETY</td>
<td>4</td>
<td>244,200</td>
</tr>
<tr>
<td>BRITISH COUNCIL</td>
<td>1</td>
<td>100,000</td>
</tr>
</tbody>
</table>
Aston Institute of Photonic Technologies has been awarded eight highly competitive Innovative Training Networks projects for the last few years in Horizon 2020 MSCA 2017 – 2020 calls. This is an enormous success for the AiPT team who achieved such great results and helped immensely in the proposals preparation – academic and research staff, AiPT project managers, our colleagues from the Research and Knowledge Exchange department and others such as Paul Knobbs and Angels Odena. This achievement consolidates the position of AiPT and Aston University as one of the most successful European institution, winning these highly competitive awards.

### ITN projects currently co-ordinated by AiPT

- **H2020-MSCA-ITN-2019**
  - MSCA-ITN-ETN – European Training Networks
    - Post Digital
      - European Training Network on Post-Digital Computing
      - PI: Prof. Sergei Turitsyn
      - Grant Agreement 860360
  - MSCA-ITN-ETN-WON
    - Wideband Optical Networks
      - PI: Prof. Sergei Turitsyn
      - Grant Agreement 814276
  - MSCA-ITN-ETN-MONPLAS
    - The training of early stage researchers for the development of technologies to MONitor concentrations of micro and nanoPLAStics in water for their presence, uptake and threat to animal and human life
      - PI: Dr. Daniel Hill
      - Grant Agreement 860755
  - MSCA-ITN-ETN-MEFISTA
    - Multi-scale fibre-based optical frequency combs: science, technology and applications
      - PI: Ass. Prof. Sergey Sergeyev
      - Grant Agreement 861152
  - MSCA-ITN-EID – European Industrial Doctorates
    - MOCCA – EID
      - Multiscale Optical Frequency Combs: Advanced Technologies and Applications
      - PI: Ass. Prof. Sergey Sergeyev
      - Grant Agreement 814276
  - MSCA-ITN-EID – European Industrial Doctorates
    - REAL-NET
      - REAL-time monitoring and mitigation of nonlinear effects in optical NETworks
      - PI: Prof. Sergei Turitsyn
      - Grant Agreement 813144
  - MSCA-ITN-EID – European Industrial Doctorates
    - FONTE
      - Fibre Optic Nonlinear TEchnologies
        - PI: Prof. Sergei Turitsyn
    - MENTOR
      - Machine Learning in optical NetwOrks
        - PI: Prof. Sergei Turitsyn

### Top 6 universities by number of ITN projects awarded:

<table>
<thead>
<tr>
<th>Rank</th>
<th>University (Country)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KATHOLIEKE UNIVERSITEIT LEUVEN (Belgium)</td>
</tr>
<tr>
<td>2</td>
<td>KOBENHAVNS UNIVERSITET (COPENHAGEN UNIVERSITY)</td>
</tr>
<tr>
<td>3</td>
<td>ACADEMISCH ZIEKENHUIS GRONINGEN</td>
</tr>
<tr>
<td>4</td>
<td>CENTRE NATIONAL DE LA RECHERE SCIENTIFIQUE CNRS</td>
</tr>
<tr>
<td>5</td>
<td>DANMARKS TEKNISKE UNIVERSITET- DTU</td>
</tr>
<tr>
<td>6</td>
<td>ASTON UNIVERSITY (at AiPT)</td>
</tr>
</tbody>
</table>

### Top UK universities by number of ITN projects awarded:

- ASTON UNIVERSITY (at AiPT) – 8
- UNIVERSITY OF LEEDS – 6
- THE UNIVERSITY OF BIRMINGHAM – 5
- UNIVERSITY OF GLASGOW – 5
- CARDIFF UNIVERSITY – 3
- QUEEN MARY UNIVERSITY OF LONDON – 3
- THE UNIVERSITY OF SHEFFIELD – 3
- UNIVERSITY COLLEGE LONDON – 3
- UNIVERSITY OF CAMBRIDGE – 1
- UNIVERSITY OF OXFORD – 1
- IMPERIAL COLLEGE LONDON – 0

For calls: H2020-MSCA-ITN-2017 to H2020-MSCA-ITN-2020

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[Reference: Research Portfolio]
Dr. Marina Zajnulina
ProDiByS – Processing Systems with Optical Delay
Host: Dr. Sonia Boscolo

Dr. Nikolai Chichkov
Mid-Infrared Laser System for High-Throughput Biorprinting by Laser-Induced Forward Transfer (MIDLIFT)
Host: Prof. Edik Rafailov

Dr. Vitali Sharma
Photonic Radar (PHRAD) Microwave Photonics
Host: Dr. Sergey Sergeyev

Dr. Maryna Pankratova
OMICRON – Optical Communication Based on Integrability and Nonlinear Fourier Transform
Host: Prof. Sergei K. Turitsyn
MULTIPLY – Marie Skłodowska-Curie Postdoctoral Fellowships in Photonics

MULTIPLY is a five-year Marie Skłodowska-Curie COFUND postdoctoral fellowship programme in photonics, coordinated by the AiPT. The programme officially commenced in October 2016, and it will offer interdisciplinary training for over 50 outstanding international experienced researchers in the areas of photonics science, technology and applications.

Prof. S. K. Turitsyn, Programme Co-ordinator
Mrs. Christiane Doering-Saad, Management Team

Dr. Srikanty Sugavanam, Programme Manager
Ms. Tatiana Kilina, Management Team

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 713694.

MULTIPLY Research Areas

The primary objective of MULTIPLY is to provide the fellows with a single framework to transferable complementary skills, research knowledge and industrial experience necessary to develop the next generation of photonic components and systems for optical networks, lasers and a wide range of photonic devices targeting biological and medical applications, nanophotonics, telecommunication and sensing applications. Training will be implemented through individual training schemes and programme-wide training activities like workshops and summer schools.

Some MULTIPLY Hosts

Triple-I Dimension

MULTIPLY fosters interdisciplinary, inter-sectoral and international research (the ‘Triple-I’ dimension). The inter-sectoral and international dimensions are underscored by placement periods with industrial collaborators and with academic organisations other than their own host.

Mobility

Mobility is an essential aspect of Marie S.-Curie Fellowships in general, and it is also carried over in the MULTIPLY framework. Both incoming and intra-European mobility options will allow Fellows of all nationalities to work in 50 member states and associate-country-based hosts.

Summer Schools and Workshops

Workshops and summer schools organised by MULTIPLY include the summer school “Complexity in Nonlinear Photonics”, held at the Lake Como School of Advanced Studies, Villa del Grumello, Como, Italy, September 25th – 29th 2017; the workshop “Photonics for Medical Diagnostics”, September 7th – 8th 2018, at the Aston Institute of Photonic Technologies, Aston University, Birmingham, UK; and the symposium/workshop “Machine Learning in Photonics”, August 26th – 27th 2019, at the University of Belgrade, Serbia. At all these events, talks were given by several leading academics in the field, together with representatives from industry. More details can be found on the MULTIPLY website.

60 Hosts
24 Fellows
7 Countries
40 Publications
23 Industry partners
52 Secondments & Placements

www.multiply.astonphotonics.uk
Dr. Nikita Toropov

Project title: PICOSSO - Ultra low-loss photonic circuit fabrication with picoseconds precision
applications for sensing and for 'hole light' devices
Host: Prof. Maha Sumateh

Dr. Nikita Toropov received his PhD degree from the MIT (Massachusetts Institute of Technology) in 2017. During his PhD, he worked on various aspects of fabrication of optical microresonators.

Dr. Lucas P. L. de Souza

Project title: BRUSHT - Developing multifunctional glass-photonic thermaliomaterials for bone cancer therapy
Host: Dr. Richard A. Martin

Dr. Lucas P. L. de Souza received his PhD degree from the University of Warwick, UK, in 2017. Since 2017, he has been a Junior Research Fellow in the Department of Physics at the University of Cambridge. His research focuses on the synthesis and application of multifunctional materials for bone cancer therapy.

Dr. Yong Yang

Project title: PINTRAIN - Photon tunneling in the surface nanomask axionics devices and simulating quantum systems
Host: Prof. Maha Sumateh

Dr. Yong Yang is an accomplished researcher who has several years of experience in the area of optics, optoelectronics, microelectronics, and nanotechnology. Prior to joining Aston University, he was a researcher at Daresbury Institute of Science and Technology, Warrington, Cheshire, UK. He is a member of the Photonics Research Group at Aston University, where he is currently working on developing new methods for simulating quantum systems using photonic devices.

Dr. Tatjana Gric

Project title: PLATINA - Developing multi-functional glass-photonic thermaliomaterials for bone cancer therapy
Host: Prof. Edeik Rafailov

Dr. Tatjana Gric received her PhD degree from Vilnius Gediminas Technical University, Lithuania, in 2012. Since then, she has been a Marie Curie Research Fellow at Aston University. Her research interests include plasmonics and metamaterials. She has published several papers on the topic of plasmonics and has been involved in various projects related to the development of multifunctional glass-photonic thermaliomaterials for bone cancer therapy.

Dr. Semen Smirnov

Project title: MULIPHY - Development of multifunctional glass-photonic thermaliomaterials for bone cancer therapy
Host: Dr. Evgeni Rafailov

Dr. Semen Smirnov has worked in the field of THz for seven years since his Bachelor's thesis at ITMO University (St. Petersburg, Russia). During these years, he has worked with almost all existing THz techniques, from initially compact and low-power semiconductor converters to powerful source systems. This extended experience is crucial for developing the unique research tools and operational methods for the future.

Dr. Otti D’Huys

Project title: MULIPHY - Development of multifunctional glass-photonic thermaliomaterials for bone cancer therapy
Host: Dr. Evgeni Rafailov

Dr. Otti D’Huys received her PhD degree in 2011 at the Ural State University of Saratov, Belgium (Applied Physics and Photonics group) after postdoctoral appointments at the University of Hamburg, Germany (Computational Physics group) and Dalhousie University, Canada (Quantum Electrodynamics). She joined Aston University in 2016 as a Lecturer in Mathematics.

Her research focuses on the development of innovative tools for early-stage disease diagnosis and cancer detection. In collaboration with the group of Dr. Richard Martin, her research includes the development of multifunctional glass-photonic thermaliomaterials for bone cancer therapy. The goal of her project is to develop new materials with properties that can be used for early detection of cancer cells and for the development of new therapeutic agents.

The project is expected to provide new insights into the interaction of light with biological tissues and to develop new methods for early detection of cancer cells. The research is expected to have significant implications for the development of novel diagnostic and therapeutic approaches for cancer treatment.

Project title: REBAP - Nanoengineering of photonic devices and the development of new applications
Host: Prof. Evgeni Rafailov

Dr. Otti D’Huys currently works on the development of new terahertz systems involving active and passive components, including novel quantum dot-based THz radiation sources.
Dr. Vitor Ribeiro
Project title: POLSAR – Polarisation and four-wave mixing transforms for optical parametric amplification
Host: Prof. Nand Doran

Dr. Nand Doran Meena
Project title: FILION: Fiber Bragg Grating-based Post and Precise Internal Monitoring of Lithium-ion Batteries in Electric Vehicles
Host: Dr. Jin Yang (MC2)

Dr. Florent Bessin
Project title: ACTOR – Addressing Comb Synchronisation in Optical Resonators
Host: Prof. Nand Doran

Dr. Aron Szabo
Project title: Optical Parametric Amplification Enhanced by Parametric Optical Feedback (OPERNET)
Host: Prof. Nand Doran

Within the scope of the MULTIPLY project OPERNET, the research fellow Dr. Aron Szabo investigates practically important aspects of optical parametric amplifiers including low-loss and low-crosstalk implementations. In the present stage of the research, a focus is on accurate and novel numerical and analytical description of nonlinear crosstalk between separate waveguide channels in parametric amplifiers. The work and the results mathematically verify the practically important link measurement technique of signals-to-crosstalk power ratio and distribution of nonlinear crosstalk noise is shown in the highly nonlinear regime. Also, it is of fundamental importance that Gaussian optical coherence is preserved over the whole optical fiber length in the process of modulation instability in passive fibre ring cavities. The results are presented at the CLEO 2020 conference under the title "Modulation instability in passive fibre ring cavities with WDM Fiber Optical Parametric Amplifiers" paper EJE4H.1. From these results, the figure below indicates an 8.8% improvement in the tolerance of a multi-waveguide multi-cavity module with the measured crosstalk power ratio as well as a highly nonlinear regime without noticeable nonlinear noise distribution for ten channels.

Dr. Ricardo Ezequiel da Silva
Project title: INCORE – High frequency in-core acoustic-optical modulators for application in dynamic optical filters and fibre lasers
Host: Prof. David Webb

I joined AiPT in October 2018 as a Marie S.-Curie MULTIPLY Research Fellow. My current research project INCORE involves (but is not limited to) the application of state-of-the-art machine learning techniques for the wavenumber mitigation in high-speed optical filters and fibre lasers. My research at that period was devoted to the problems of computational and theoretical nonlinear acousto-optics, optoacoustics and magnetoacoustics. I received my PhD in Theoretical Physics in 2009 from Verkin Institute for Low-Temperature Physics and Engineering, Ukraine. After my PhD, I worked as a Visiting Fellow at Pavol Jozef Safarik University in Košice, Slovakia. My research at that period was devoted to the problems of computational and theoretical nonlinear acousto-optics. Within the scope of the MULTIPLY project MARCONI, I was awarded with a binational PhD degree in Electrical Engineering from the Federal University of Technology – Paraná (UTFPR) in Brazil and Technical Physics Engineering from Friedrich-Schiller-Universität in Germany. In 2016, I joined the Graduate Program in Electrical and Computer Engineering at UTFPR, researching in the fields of dynamic optical filters and fibre lasers.

I joined the AIT as a Marie Skłodowska-Curie MULTIPLY Fellow since June 2019, leading a research project in cooperation with groups in the UK, Germany and Poland. My research at AiPT was devoted to the problems of computational and theoretical nonlinear acousto-optics, optoacoustics and magnetoacoustics.

Dr. Oleksandr Kotlyar
Project title: MARCONI – Machine learning for nonlinear Fourier-based optical communications
Host: Prof. Sergei K. Turitsyn

I received my PhD in Theoretical Physics in 2006 from V.I. Vernadsky Institute for Low Temperature Physics and Engineering, Iasi, Ukraine. After my PhD, I worked as a Research Fellow at the same Institute. In 2011 I was a Visiting Fellow at Paul Freulich Institute for Nanoscale Physics and Photonics, Miami, USA. My research at that period was devoted to the problems of computational and theoretical nonlinear acousto-optics. Within the scope of the MULTIPLY project MARCONI, I was awarded with a binational PhD degree in Electrical Engineering from the Federal University of Technology – Paraná (UTFPR) in Brazil and Technical Physics Engineering from Friedrich-Schiller-Universität in Germany. In 2016, I joined the Graduate Program in Electrical and Computer Engineering at UTFPR, researching in the fields of dynamic optical filters and fibre lasers. I joined the AIT as a Marie Skłodowska-Curie MULTIPLY Fellow since June 2019, leading a research project in cooperation with groups in the UK, Germany and Poland. My research at AiPT was devoted to the problems of computational and theoretical nonlinear acousto-optics, optoacoustics and magnetoacoustics.
AiPT offers extensive educational opportunities to its students, including master’s-level courses, master’s by research courses and PhD studies. At AiPT we integrate research with education to generate and advance knowledge in photonics and to translate scientific breakthroughs into technology with industrial, economic and societal impact. Our MSc and PhD programmes are designed to provide modern industry with a highly-qualified workforce by training a new generation of creative, entrepreneurial and innovative researchers, able to face current and future changes and to convert knowledge and ideas into products and services for economic and social benefit. The Institute comprises a mixture of theoreticians, modellers and experimentalists working together in its outstanding facilities and infrastructure housed in more than 30 laboratories covering 1500 square metres, since 2018. Being an active member of a range of European funding schemes, AiPT is currently involved in different European Horizon 2020, research infrastructures, and business schemes (SMARTNET and EID projects) and direct industry contracts. Thus, AiPT is recognised as a centre of excellence in photonics, with global international visibility, and is a beacon of photonic learning and public outreach activities, making it among the top-ranked academic photonic centres in the world.
SMARTNET
(Smart Telecom and Sensing Networks)
Total budget: €4m, Aston part ~€1.6m.
Coordinated by APT (Dr. S. Sygletos, Prof. S. Turitsyn, Tetyana Gordienko) and including Université Paris-Saclay (Telecom SudParis and Telecom ParisTech) and University of Athens, the programme aims at the education of MSc students in the inter-disciplinary fields of photonic and 5G wireless technologies for data communication, sensing and big data processing. Industrial partners of SMARTNET include Airbus, Alcatel-Lucent, Orange, Network Rail, Coriant (former Siemens Optical Networks) and 14 other large companies and SMEs.

PIXNET
(Photonic Integrated Circuits, Sensors and Networks)
Total budget: €3.684m, Aston part ~€0.8m.
Coordinated by Scuola Superiore Sant’Anna (Pisa, Italy) and including Aston University, Technische University Eindhoven and Osaka University, this programme aims at the education of MSc students in design, implementation and application of innovative integrated devices based on photonic technologies. Industrial partners of PIXNET include Ericsson KDDI R&D Laboratories (Japan) and 17 other companies.

Erasmus Mundus Joint Master Degree Projects
SMARTNET and PIXNET
SMARTNET and PIXNET are two prestigious five-year Erasmus Mundus Joint Master Degree programmes in 5G and photonic technologies, led by Dr. Stylianos Sygletos and Prof. Sergei K. Turitsyn. The programmes are delivered by an international consortium of top-level higher educational institutions. More than 500 applicants have applied since their beginning in 2018 and more than 60 candidates have been admitted in total. The first intake is about to complete with success and the second intake is in the middle of the two-year schedule. The third intake will enrol in September 2020.

MSc Smart Telecom and Sensing Networks (SMARTNET)
Programme Overview: SMARTNET is a twocycle (120 ECTS) joint master’s degree programme supported by European Union funding and provided by three universities (Aston, Telecom SudParis and University of Athens) of distinctive and complementary academic qualities and strong educational and research traditions. Its training programme is based on well-defined mobility paths designed to award multiple degrees depending on the chosen curriculum.

Curriculum and Mobility: students may start from any of the three institutions where they will spend the first two semesters and receive the core part of their training. The third semester will be carried out in a different institution and will include specialisation courses that enhance the interdisciplinary nature of the offered degree. The fourth semester students will conduct an individual project and report on an MSc thesis.

Admission may be granted to applicants who meet the following minimum common criteria:
- A bachelor’s degree of at least 180 ECTS in one of the following fields: telecommunications, electronic or electrical engineering, computer science, physics, mathematics, or similar
- Cumulated Grade Point Average (CGPA) of at least 75% of the scale maximum
- Advanced English language skills that correspond to at least level C1 of the Common European Framework of Reference

Why should students choose the SMARTNET course?
- To study one of engineering’s key multidisciplinary areas of the future
- To develop the skills and knowledge to contribute to the development of a 5G network infrastructure
- As part of the Erasmus Mundus programme, students graduate with two full MSc qualifications
- To benefit from close relationships with 19 industrial partners

Contacts:
- www.smartnet.astonphotonics.uk
- aipt_smartnet@aston.ac.uk

Assoc. Prof. Stylianos Sygletos, Programme Director
Prof. Sergei K. Turitsyn, Programme Coordinator
Tetyana Gordienko, Project Administrator

SMARTNET and PIXNET programmes have received funding from Erasmus+ Programme of the European Union

MSc courses in SMARTNET and PIXNET

Programme Overview: SMARTNET is a two-year (120 ECTS) joint master’s degree programme supported by European Union funding and provided by three universities (Aston, Telecom SudParis and University of Athens) of distinctive and complementary academic qualities and strong educational and research traditions. Its training programme is based on well-defined mobility paths designed to award multiple degrees depending on the chosen curriculum.

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- To benefit from close relationships with 19 industrial partners

Contacts:
- www.smartnet.astonphotonics.uk
- aipt_smartnet@aston.ac.uk
Why should students choose the PIXNET course?

SMARTNET and PIXNET students are delighted by the obtained educational experience. They appreciate that exposure to the deep and diverse knowledge offered by the different academic institutions, and for the opportunity to travel around the world. Both programmes focus on scientific and soft skills development, personal growth and multicultural awareness, and of course, participants may obtain a double MSc degree in a "hot" technological area. All of this makes them unique and exceptional.

Students’ Experience

SMARTNET and PIXNET students are able to choose from six different mobility paths involving two or three programme universities: Scuola Superiore Sant’ Anna (Pisa, Italy), Aston University (Birmingham, UK), Technische Universiteit Eindhoven (Netherlands) and Osaka University (Japan).

They study subjects in English, offering their students the opportunity to learn and to improve their language skills. The programme teaches knowledge and skills that are essential in the job market and support their future career development, personal growth and multicultural awareness.

Course Details

Aston University covers the following courses in the EMIMEO programme:

- Digital Communication and Information Theory (15 UK credits)
- Radio Systems and Personal Communication (15 UK credits)
- Broadband Wireless Networks (15 UK credits)
- 5G Signal Processing (15 UK credits)
- Optical Communications System (3 ECTS)
- Project Management (UK credits 15)
- Machine Learning
- Internet of Things
- Artificial Intelligence
- Machine Learning
- Optical Communication Systems (3 ECTS)
- Mobile Data Networks (ECTS)
- Optical Networks
- Internet of Things
- Digital Communication and Information Theory (15 UK credits)

As a student of the EMIMEO programme, you will be able to choose two or three full semesters that will result in either a double MSc degree or a single 15-credit MSc degree. You will receive the diploma from each institution in which you will have spent at least one semester of study. Aston will issue the MSc degree certificates in accordance with the regulations of the Basque Country, students will benefit from distinctive and complementary academic qualities and strong educational and research environments. Together with the industrial partners, including SMEs and big companies, the EMIMEO consortium aims at building the best training on offer for future engineers and professionals that are interested in microwave electronics and photonics.

Erasmus Master on Innovative Microwave Electronics and Optics (EMIMEO)

Contact:

- Aston University: emimeo-consortium@unilim.fr
- https://www.facebook.com/EMIMEO.EU/
- http://www.erasmus-master.emimeo.eu/
- Emimo.masters.ub.edu
- Aston University: https://www.astro-photonics.uk
- aipt.pixnet@aston.ac.uk
- www.smartnet.astonphotonics.uk
- Schools of Electronics, Electrical, and Computer Engineering, Aston University, UK
Mr. Abdallah A.I. Ali

Kerr Non-linearity in optical communication systems
Prof. Andrew Ellis

Viva defence date: 14th May 2020.

Mr. Mahmood Abu Romoh

Digital converters for next generation of optical transceivers
Prof. Wladek Forysiak, Dr. Paul Harper and Prof. Sergei K. Turitsyn

Mr. Mike Anderson

Researching the role of field programmable gate arrays (FPGAs) in the design and manufacturing of Super Channels Transceivers
Prof. Wladek Forysiak

Mr. Peiypn Cheng

Ultrafast New laser based on materials and nonplanar fibre structure
Prof. Sergei K. Turitsyn

Mr. Aleksandr Donidin

Blancard-based ultra broadband fibre amplifiers
Prof. Sergei K. Turitsyn

Mr. Pedro-Fraire De Carvalho-Soura

Machine Learning Techniques for nonlinearity mitigation
Prof. Sergei K. Turitsyn and Dr. Yaroslav Prilepsky

Mr. Nasir Garba Bello

Development of a compact, tunable, room temperature operation and tenability generation system
Prof. Cali-Usyadi, and Prof. Sergei K. Turitsyn

Ms. Gabriella Gardosi

Bowe-Eckoldt (SNAP) nanocomposites
Prof. Mike Sweeney

Mr. Chandra Gaur

Thermal Application of Non-Optic Parametric Amplifiers
Prof. Andy Crane

Mr. Pratim Hazarika

Ultra-Broadband Raman amplifiers for wideband optical networks
Prof. Wladek Forysiak

Mr. Mohammad Hosseini

Novel digital signal processing techniques for nonlinear fibre systems
Prof. Sergei K. Turitsyn and Dr. Yaroslav Prilepsky

Mr. Igor Kudelin

Ultrafast New laser-based supercontinuum
Dr. Sikandar Bagiapani

Ms. Yang Lu

Calibration of Photons for Optical Coherence Tomography
Prof. Kate Sugden

Mr. Mohammad Hosseini

Machine learning based nonlinearity mitigation in non-optic communication systems
Prof. Sergei K. Turitsyn and Dr. Yaroslav Prilepsky

Ms. Karina Nurlbybayeva

Machine learning based control of Optical communication
Prof. Sergei K. Turitsyn and Dr. Sotos Generalis

Ms. Ray Paulami

Advanced semiconductor nonlinear crystals for the generation of MIR light in broad wavelength ranges
Dr. Natalia Bazieva and Prof. Edik Rafailov

Ms. Namita Sahoo

Advanced fibre gratings extending to visible and mid-IR and applications for food quality control and environment monitoring
Prof. Lin Zhang

Mr. Pavel Skvorcov

Optical communication systems for metropolitan area network applications
Prof. Wladek Forysiak

Mr. Victor Vasileiev

Frequency comb generation in a micro resonator on the Surface Nanolaser Axial Photonic platform (SNAP)
Prof. Kate Sugden and Dr. Sotos Generalis

Ms. Anastasiea Vozychenkova

Nonlinear Transient Transfer in Applications To Long-Haul Optical Communications
Prof. Sergei K. Turitsyn, Dr. Renalto Plikop, Dr. Gaye Girev and Dr. Anti Drebraplovski

Viva defence date: 25th April 2020.

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SNAP devices with enhanced impedance-matched transmission bandwidth
Prof. Mike Sweeney and Dr. Sorin Marinescu

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During my PhD at AIFT, I have been involved in the organisation work in the professional development of public outreach, leading for many years in the role of co-founder and President the Aston University OSA chapter. Also, I have supported and organised a series of workshops and outreach activities with local schools. Beyond my research work in photonics, I am actively working in the educational context in setting up research-related talks, presenting and defending the research work results as a competitive way. This event is widely appreciated for its social and educational value, especially in preparing the next generation of talented researchers in this field.

My PhD position at AIFT is within the Nonlinear Fourier Transform research group. The project I am working on is addressing the development of new advanced methods for minimising nonlinearity in optical fibres. Our goal is to increase the capacity of optical communication systems, to satisfy worldwide data traffic demands, however, higher capacity systems require higher power signals inducing nonlinear effect, which spoil the received information. We are developing the Nonlinear Fourier Transform approach, which utilises the nonlinearity of the optical fibre as a part of the model. Within this model, the optical signal can be decomposed to the effectively decoupled “nonlinear” modes, which are not interacting, while the signal is propagating in the fibre. The main challenges of this research are to make the processing algorithms sufficiently fast, despite the fact that they involve advanced mathematics; also, we need to overcome high signal sampling requirements, to be able to compete with the currently achievable data rates. Another challenge is to get rid of the effective noise affecting the nonlinear modes during the signal propagation.

In this area, we have achieved results widely acknowledged in the community in designing the periodic nonlinear Fourier transform communication systems, employing the solution of the Riemann–Hilbert problem. Research into this area is still very active, and my research work in photonics, accepted to Journal of Lightwave Technology (2020). I am actively working in the educational sector, being, above all, the UK representative of the Organising Committee of the International Physicists' Tournament. In this role, I am working in arranging the educational context in setting up research-related talks, presenting and defending the research work results as a competitive way. This event is widely appreciated for its social and educational value, especially in preparing the next generation of talented researchers in this field.

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As I have mentioned in the previous section on Communication Systems, signal flow into fibre, with higher values, than the observed signal, which spoil the received information. We are developing the Nonlinear Fourier Transform approach, which utilises the nonlinearity of the optical fibre as a part of the model. Within this model, the optical signal can be decomposed to the effectively decoupled “nonlinear” modes, which are not interacting, while the signal is propagating in the fibre. The main challenges of this research are to make the processing algorithms sufficiently fast, despite the fact that they involve advanced mathematics; also, we need to overcome high signal sampling requirements, to be able to compete with the currently achievable data rates. Another challenge is to get rid of the effective noise affecting the nonlinear modes during the signal propagation.

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Pavel Skvortcov

I am a final year PhD candidate at Aston Institute of Photonic Technologies (AiPT) working in the field of fibre-optic communications under supervision of Prof. Wladek Forysiak. Before joining AiPT, I obtained a strong grounding in applied physics and mathematics during my studies at Moscow Institute of Physics and Technology (MIPT). Also, I had two years of industrial experience working in R&D in Russian leading company "T8".

My main research interests are related to the development of modern fibre-optic communications: advanced digital signal processing, advanced coded modulation, transceiver optimization and high-speed transmission.

Digital coherent technology is now mainstream in high-performance, long-distance fibre-optic communication systems, but significant research is needed to enable scaling towards future support of terabit/s transceivers. My PhD project "Optical Communication Systems for Metropolitan Area Network Applications" is a part of the EPSRC project "Towards Manufacturing of Massive WDM Metro" (ToM3). It aims to investigate technologies, architecture and manufacturing needs of modern high-speed digital coherent transceivers for metro area applications in order to improve yield and performance of the transmission system.

In particular, the project covers aspects of transmission optimization and impairments compensation by utilizing on-board digital signal processing, as well as advanced coded modulation techniques.

During my PhD programme I had a half-year industrial internship at Mitsubishi Electric Research Laboratory (MERL) in Boston, MA, USA. It gave me an excellent opportunity to work with world-leading experts in the field, gain knowledge and produce new research ideas. My research at MERL was focused on advanced coded modulation, probabilistic constellation shaping and nonlinear system performance optimization. This work resulted in multiple publications and ongoing collaboration between AiPT and MERL.

Key publications:

I have learnt a lot of practical skills such as project management, effective communication and problem-solving.

Yang Lu

I joined AiPT in 2017, pursuing my PhD degree under the supervision of Prof. Kate Sugden and Dr. Vladimir Mezentsev.

My main research interests are related to the femtosecond laser inscription, optical coherence tomography (OCT) and OCT calibration phantom fabrication. I am currently working on the femtosecond laser inscription optimisation for the fabrication of OCT phantoms and the applications of the OCT phantoms. In particular, where the phantom can be used as a calibration tool to validate post-processing algorithms used to correct image distortion caused by OCT system. This research work is critical and essential to OCT systems and their application in medicine which has experienced rapid development since the early 1990s. Present research work aims mainly to exploit on the OCT calibration phantom in processing and is becoming a commercial product with more comprehensive tests in different OCT systems.

I also have the opportunity to work in industry during my PhD studies as my PhD project is co-funded by both the university and the industrial partner (Arden Photonics Ltd.). Through working in the industry, I have learnt a lot of practical skills such as project management, effective communication and problem-solving.

Key Publications in 2019 – 2020:

I have learnt a lot of practical skills such as project management, effective communication and problem-solving.
### Doctoral Theses Awarded in 2018 – 2020:

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<tr>
<th>Student's Name</th>
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<td>Mr. Michal Zubel</td>
<td>Prof. Kate Sugden</td>
<td>February 2020</td>
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</table>
Industrial Collaboration

AiPT contributes to improvement of regional economic and innovation performance through engagement with large, medium and small businesses across the West Midlands and helps them to develop new capabilities, products and services. We welcome collaboration opportunities with industry around the UK and worldwide.

Contact: Dr. Kaiming Zhou, Head of AiPT Industrial outreach Laboratory, k.zhou@aston.ac.uk

AGRI Project Overview

The AGRI project (Agri-tech Growth and Resources for Innovation) has been funded by the European Regional Development Fund receiving £1.2 million in funding towards the overall project cost of £2.1 million.

The project was co-delivered in partnership between Harper Adams University and the team from the AiPT, Aston University in the Marches Local Economic Partnership area covering Shropshire and Herefordshire and has been developed to address identified barriers to innovation and growth in the agri-food industry by providing an innovation support service focused on companies involved with agri-tech, food and drink manufacturing and logistics. The timeframe for the project delivery was from March 2017 to February 2020 with the project successfully supporting 85 small and medium enterprises.

The support was provided a combination of workshops and one-to-one business advice, which included assistance with technology development and the development of technology applications. It also facilitated the development of a network for peer advice and SME collaboration with seven workshop events facilitated at a number of venues across the Marches area in collaboration with a number of regional support agencies and specialist private sector companies in areas such as robotics, IP management, legal and tax advice.

The 85 companies engaged on the project all received one-to-one support focused on their innovation requirements, which were identified at initial diagnostic meetings and then further developed through an innovation review and action plan to take the ideas forward. Of these 85 companies, 22 went on to receive further longer-term collaborative support from Aston and Harper Adams University in developing their innovative through to prototypes and market launch stages.

The project is currently awaiting assessment on a funding application to extend the innovation support programme for a further three years.
Enabling Technologies

The Enabling Technologies & Innovation Competences Challenge Project is a three-year long £2.8m project, part-funded by the European Regional Development Fund (ERDF). The ETICC project started in August 2018 and is running until 31st July 2021. The project aims to solve a range of innovation challenges by supporting 129 small and medium businesses and is running until 31st July 2021. The Project aims to solve a range of innovation challenges by supporting 129 small and medium businesses.

Examples of the funded support available to businesses include: product design, engineering analysis, electronics development, new product planning and development, production assessment, market research, technical feasibility, engineering prototyping, photonics and electronics technology integration, advanced manufacturing, using lasers, photonic and materials knowledge transfer workshops, photonic sensor development and adaptation, concept generation, novel lasers and market research, technical feasibility, engineering prototyping, photonics and electronics technology integration, advanced manufacturing, using lasers, photonic and materials knowledge transfer workshops, photonic sensor development and adaptation, concept generation, novel lasers and market research, technical feasibility, engineering prototyping, photonics and electronics technology integration, advanced manufacturing, using lasers, photonic and materials knowledge transfer workshops, photonic sensor development and adaptation, concept generation, novel lasers and market research, technical feasibility, engineering prototyping, photonics and electronics technology integration, advanced manufacturing, using lasers, photonic and materials knowledge transfer workshops, photonic sensor development and adaptation, concept generation, novel lasers and market research, technical feasibility, engineering prototyping, photonics and electronics technology integration, advanced manufacturing, using lasers, photonic and materials knowledge transfer workshops, photonic sensor development and adaptation, concept generation, novel lasers and market research, technical feasibility, engineering prototyping, photonics and electronics technology integration, advanced manufacturing, using laser...
The Wolfson Centre of Excellence

AIFT has established a Wolfson Centre for Photonics for Food and Agri-tech funded by the Wolfson Foundation £500,000 equipment grant. The centre is led by Prof. Sergei Turitsyn and Prof. David Webb, and it focuses efforts of AIFT in the emerging field of application of photonic technologies in the food industry and agri-tech. This area is one of the strategic emerging research directions of AIFT. In making this award, the Wolfson Foundation acknowledged photonics research at Aston to be world leading. Andrew Harris, Executive Director of Campaigns at Aston University, has played a critical role in facilitating this grant application and award.

The initial research of the new centre is focused on food packaging, mid-IR /near-IR fibre optical sensors for measurement of nutrient constituents in food, optical fibre sensors with coated nano materials for measurement of concentration of glucose and development of technologies to monitor concentrations of micro and nano plastic in water. In addition to undertaking research, the centre has a strong commitment to promoting the take-up of photonics technologies by industry in the agri-sector, supported by ERDF funding. In 2019, as a part of the activities of the new centre, AIFT became a member of the UK Science and Technology Facilities Council Food Network+ (SFN+).

The Wolfson Foundation awards grants to support and promote excellence in the fields of science and medicine, the arts and humanities, education and health and disability. The majority of grants from the Wolfson are for capital infrastructure, i.e. buildings (new build and refurbishment) and equipment. The aim of the foundation is to promote ‘excellence’ in each category/field they fund and their decision-making is rigorous, with funding being provided on the basis of expert peer review.

The Wolfson Foundation website: https://www.wolfson.org.uk

International Cooperation

Newton Fund Institutional Links Research Project with Indonesia 2018 – 2020

“Fibre optic sensor for food safety applications” is a Newton Fund Institutional Links research project that has been developed in collaboration with Airlangga University in Indonesia from 2018 to 2020. The aim of the project was to develop fibre-based optical sensors for efficient detection of formalin (a solution of formaldehyde in water) in food. Formalin is a highly toxic and cancerous chemical substance that is illegally added by rouge trades to fish, meat, milk and other kinds of food samples in order to make them look fresh for a long time even when they are not anymore. This illegal practice is extremely dangerous, can cause serious damage to the population and constitutes a social challenge in Indonesia. Photonics could provide faster and cheaper detection methods, compared to existing techniques in chemistry, suitable for measurements in the field.

The project’s PIs are Prof. S. K. Turitsyn at AIFT and Prof. M. Yasin at Airlangga. Dr. A. M. Perego and Dr. H. Kbashi from AIFT and Dr. A. Zaidan and Dr. N. Irawati from Airlangga University are the postdoc researchers who have been involved in the research.

Optical methods such as light scattering and fluorescence have been tested for non-invasive and agile detection of formaldehyde in various experiments carried out both in the UK and Indonesia. The project has led, so far, to one journal paper publication in Optical Fiber Technology and more papers are in the pipeline.

Furthermore, the project has enabled reciprocal research visits and fruitful knowledge transfer between UK and Indonesian institutions including: Airlangga’s research attending a workshop at Aston; Aston students delivering lectures and tutorials on photonics to Airlangga University students and speaking at a local conference; and the visit of the delegation of Ristekdikti (the Indonesian Ministry for Research and Technology) and the Indonesian British Council to Aston University in December 2019.

Most importantly this project constitutes the starting point for future strong research and educational relations between Aston and Airlangga University and other Indonesian institutions.
List of Seminars in 2019 – 2020:

Prof. Mikhail I. Kolobov, Laboratoire PhLAM, Université de Lille, France
Temporal imaging with squeezed light

Prof. Alexander Giles Davies, Professor of Electronic and Photonic Engineering and Pro-Dean for Research and Innovation for the Faculty of Engineering, University of Leeds
Terahertz technology: from devices to applications

Prof. Arthur Lowery, Monash University, Australia
The Marriage of Electronics and Photonics: Any Children?

Prof. Hui Cao, Dept. of Applied Physics, Yale University
Controlling light propagation in multimode fibers

Mr. Alexey Kokhanovskiy, NSU, Russia
Machine learning based characterisation of dissipative solitons

Dr. Irina V. Larina, PhD, Associate Professor, Molecular Physiology and Biophysics, Baylor College of Medicine, Houston, USA
Shining light at development

Dr. Konstantin Gorbachyev, Project Manager, Laser Systems Department, SOLARLS JSC (Minsk, Belarus)
High-power solid laser and laser systems

Dr. Antonio Napoli, Project Coordinator and Leader, Advanced Research Topics, OIF Representative at Infinera Germany

Prof. Jayavel Ramasamy, Crystal Growth Centre, Anna University, India
Semi-organic Non-linear Optical Crystals for Second Harmonic Generation and Frequency Conversion Applications

Prof. Mircea Guina, Tampere University of Technology
Advances in InGaAs-based optoelectronic technology - Bridging material science to applications

Dr. John Dudley, University Bourgogne Franche-Comté and CNRS Institute FEMTO-ST, France
Unexpected Ultrathin - Extreme Light, the Nobel Prize and the History of Nonlinear Science

Dr. Andrei Kabashin, French National Center for Scientific Research (CNRS) and Aix-Marseille University, Marseille (France)
Laser ablative access to the synthesis of new functional nanomaterials for biomedical applications

Dr. Alessia Pasqua, Reader in Physics at the University of Sussex
Microcombs Based on Laser Cavity Solitons

Dr. Alexander Doronin, Victoria University of Wellington, School of Engineering and Computer Science, Wellington, New Zealand
Dual application of engineered materials and their applications in Computer Graphics, Biomedical Imaging and Artificial

Dr. Tatiana Novikova, École Polytechnique, Institut Polytechnique de Paris, Palaiseau, France
Polarimetric imaging as Ariadne’s thread towards optical biopsy and metrology

Dr. Andrei Kabashin is giving a talk to the AiPT team on “Laser ablative access to the synthesis of new functional nanomaterials for biomedical applications”.

The AiPT team runs a series of scientific seminars covering a broad range of topics, from experimental and theoretical problems of photonics to industrial applications. In 2019 AiPT hosted academic seminars for non-AiPT researchers to exchange ideas, current state-of-the-art research in photonics, machine learning, optical communication, etc. All seminars in AiPT are open to a wider public.
In December 2019 AiPT organised its Annual Research Conference where academics presented their groups and current research projects. The event was followed by the Christmas celebration 2019 with a pub quiz, AiPT’s Got Talent, Xmas Foosball tournament and other activities.

On 26th February 2020 two Horizon 2020 Innovative Training Network projects, EID REAL-NET and ETN WON, coordinated by AiPT, jointly organised their first technical workshop at Aston University, UK. The workshop comprised one day-long meeting where work package leaders from both projects, industrial partners, external speakers and early-stage researchers presented their scientific technical presentations. The workshop provided an opportunity to discuss the scientific progress within the projects and the future directions of work. It also brought together leading researchers in the fields of optical transmission systems and fibre communication:

- Dr. Lidia Galdino, a Lecturer, Royal Academy of Engineering Research Fellow from University College London (UCL) gave a talk titled “State of the art in digital coherent transmissions”
- Dr. Ian McClean, a product manager from II-VI Photonics presented a talk “State of the art in amplifiers”
- Prof. Andrew Lord, a Senior Manager of Optical Research at BT Group talked about “The future of optical fibre communications: an operator’s perspective”

The workshop provided an opportunity to discuss the scientific progress within the projects and the future directions of work.
ITN Cross Workshop on Transferable Skills

On 27th – 28th February 2020 AiPT hosted an intensive workshop on Transferable Skills organised by ITN projects coordinated by AiPT for the early-stage researchers from EID FONTE, EID MOCCA, EID REAL-NET and ETN WON.

15 hours of training covered 10 sessions during two days of the event. High caliber and engaging speakers included Dr. Annmarie Hanlon (digital marketing) on engaging with social media; Stephen Harris (Editor of “The Conversation”) on Writing for media; Dr. Rachel Won (editor of “Nature Photonics”) on writing a great paper; Dr. Srikanth Sugavanam (MULTIPLY Programme Manager) on academic writing, as well as an additional presentation on intellectual property, patenting and open access. Day two was handed over entirely to Dr. Richard Fallon (The Marketing Engineer) on influencing, marketing yourself, creating perfect presentations, networking and teamworking. The event was finished with a fun and tasty evening at the Harborne Food School, cooking and eating an entire four-course Indian meal in good company.

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ETICC Project: Women, Innovation, Technology & Strength Event in March 2020

The Enabling Technologies & Innovation Competencies Project, part-funded from the European Regional Development Fund, has a number of special conditions for its delivery that include sustainability and support for sustainable development and equality and diversity.

To support the equality and diversity theme the project team developed and hosted the Women, Innovation, Technology & Strength event on Friday 6th March 2020 in collaboration with Shakti Women, an organisation that focuses on support and empowerment of women and girls. The event was timed for the International Women’s Day, and its aim was to tell the stories of different women to inspire more women and girls to enter the engineering and technology fields.

Speakers shared stories based on events in their life, about ups and downs, and about what encouraged them to follow their dreams. This event was also a learning and networking opportunity designed by women for women. Attendees had the chance to hear and learn from other successful and like-minded women in business and science.

The event had a very positive audience feedback and generated five new leads for the ETICC project.

Focuses on support and empowerment of women and girls
AiPT members reached out to industry as a part of the team representing the Aston Institute of Photonic Technologies at the Photonex Europe 2019 exhibition event in Coventry, UK. Photonex is the UK’s premier event dedicated to photonics, imaging and optical technologies from pure research to development of bespoke advanced user solutions. Photonex brings the whole supply chain together under one roof: supplier companies, consultants, industrial users, researchers, science groups and innovative newcomers.

Pic: AiPT members at Photonex 2019, UK

Members of the AiPT OSA SPIE student chapter, together with Aston WEST, participated in the outreach event explaining optics to undergraduate students and celebrated the International Women’s Week Speed Networking event to promote the student chapter.

Pic: AiPT members at Big Bang Fair 2019 (right to left): A. Vasylchenkova, M. Pankratova and O. Kotlyar

AiPT members at Big Bang Fair 2019 (March 13th – 16th 2019)

The Big Bang UK Young Scientists & Engineers Fair is the largest celebration of science, technology and engineering. It is a large annual event attracting thousands of students aged 11 to 15 for STEM showcases exhibition. AiPT members, Anastasiia Vasylchenkova, Marina Pankratova and Oleksandr Kotlyar, took part in the stand of Aston University in 2019, which was themed to STEM superheros. Children were getting super abilities in activities around the stand such as strength and levitation.

Pic: AiPT members at Big Bang Fair 2019 (right to left): A. Vasylchenkova, M. Pankratova and O. Kotlyar

Photonex Europe 2019, Coventry, UK, October 2019

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Pic: AiPT members at Photonex 2019, UK

Outreach

Outreach
Outreach activity 24th February 2020

AIP Project Managers – Christiane Doering-Saad (EID FONTE), Martina Pasini (EID REAL-NET) and Felicita Tramontana (EID MOCCA) – led an outreach event to ERASMUS students in AIP’s SMARTNET and PIXNET Erasmus Mundus Joint Master Degrees, explaining MSCA PhDs, how they differ from ‘ordinary’ PhDs and how they can be found on the EU job portale EURAXESS. Attended by students of both EMJMD programmes, the talk has also been made available to students not currently at Aston University, thus reaching the cohorts are completely about 150 master’s students.

Optics Demonstrations at Birmingham Primary School, 14th February 2020

On 14th February 2020 AIP members Aleksandr Donodin, Vladislav Neskorniuk, Gosia Dzierdzikowska and Payal Baheti organised an outreach activity at Birmingham Primary School (UK) during the School Careers Fair. They presented different demonstrations on light, optics and photonics to the kids of the age of 10-11 and talked with them about engineering, physics and science.

Photo Credit: Dr. Srikanth Sugavanam

Demonstration of different light sources and optical phenomena, along with interactive science kits. Clockwise from top left: Beam splitter, focusing a beam on a single point; Coloured slit sources focused by a cylindrical lens; Demonstration of total internal reflection (TIR) - red light is total-internally reflected; Artistic image of the coloured slit sources; Red and green lasers combined using TIR and made incident on a plastic grating, demonstrating wavelength dependence of diffraction orders.
We welcome collaboration opportunity with academia, research institutes and industry around the world.

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