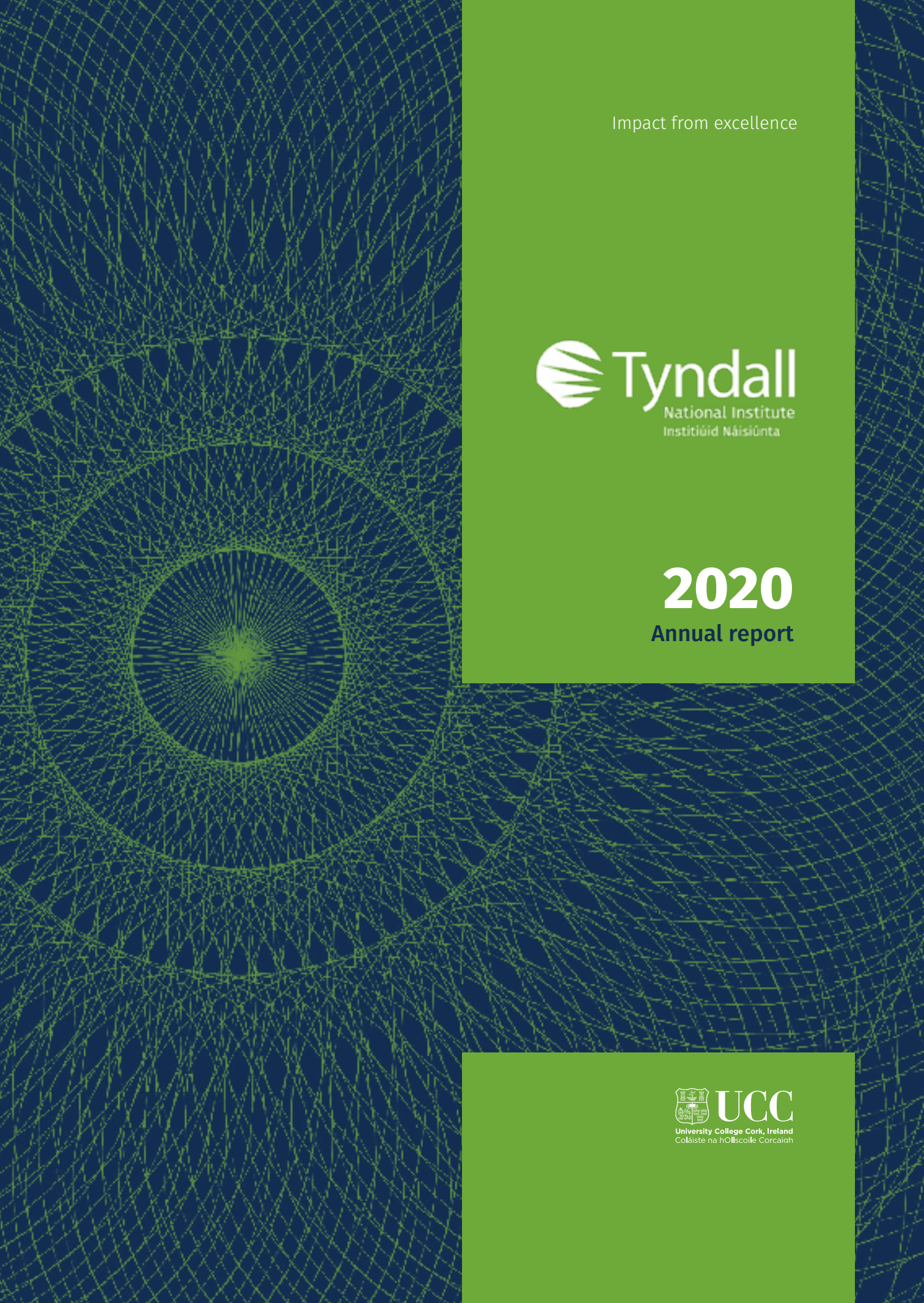
Impact from excellence



Tyndall
National Institute
Institiúid Náisiúnta

2020
Annual report

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Contents

Chairperson's message

During 2020, Tyndall had to deal with many challenges posed by the significant restrictions associated with the Covid-19 pandemic.

Tyndall's essential research activities are heavily dependent on access to labs and equipment and require high levels of interaction and networking across disciplines. In particular, I would like to thank the support staff who worked unstintingly in the background for their outstanding success in enabling and facilitating our continued safe operations during the year, while fully compliant with public health guidelines.

That ability to remain open was particularly important for our many researchers and students from overseas who found themselves cut off from friends and family in their home countries during the pandemic, and being able to continue to undertake their essential research work and interact safely with colleagues was of enormous value.

A key objective for us is the creation and retention of high-quality sustainable jobs through effective industry-academia collaboration. We achieve this through the high quality of our research, the excellence of our national research infrastructure, and our international standing and reach.

Research excellence is at our very core. Our world leading research creates the reservoir of knowledge which we transfer to our industry partners. It is also a key differentiator that attracts some of the world's best researchers to come and work with us at Tyndall, as well as the unique breadth and scale of our research activities. By bringing together capabilities in microelectronics, nanotechnology, and photonics and by acting as host or spoke to a number of Research and Technology Centres such as the Irish Photonic Integration Centre (IPIC), Connect and Confirm as well as the Microelectronic Circuits Centre Ireland (MCCI) and the International Energy Research Centre (IERC), Tyndall provides unparalleled scale and opportunities for multidisciplinary working.

Combining this with our state-of-the-art research support infrastructure presents a compelling proposition for both researchers and industry collaborators.

That capability is also fundamental to our international success and relevance. For example, deep-tech research is at the heart of a successful Europe and the team at Tyndall is behind some of the world's most advanced research in this exciting new frontier. The deep-tech we are developing will have a huge impact in creating solutions for some of the greatest challenges facing society now and in the future in areas such as climate change, healthcare, and energy production.

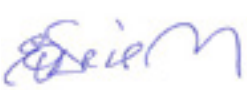
2020 also saw Tyndall expand our national footprint with the creation of the Wireless Communications Research Laboratory in Dublin. The new lab will host a wireless communications team that will focus on future telecommunication technologies. The resulting innovations will be of significant benefit to industry and has the potential to create high value start-ups with global impact.

An Taoiseach Mr Micheál Martin TD also visited Tyndall to discuss progress on our ambitious planned expansion, which will effectively double the size of the Institute, and also to officially open the new Electron Beam Lithography Lab which is a unique and valuable facility for research in Ireland.

We were delighted that our Board member and former Tyndall student and researcher Dr Ann Kelleher was awarded the prestigious Science Foundation Ireland (SFI) St. Patrick's Day Science Medal during the year. Ann is Senior Vice President and General Manager of Technology Development at Intel Corporation and has maintained her strong interest in and support of Tyndall throughout her stellar career.

Tyndall operates under a unique Agreement between the Minister for Further and Higher Education, Research, Innovation and Science and University College Cork (UCC). The Agreement defines the primary role of Tyndall as providing a national focal point for excellence in deep-tech research, development and graduate training at the convergence of micro & nano-electronics, photonics, materials and software, with the objective of having a significant impact on economic development and societal challenges in Ireland.

I would like to express my thanks to UCC and the Department for their collaboration in support of the Agreement and to my board colleagues for their diligent work to strike the right balance for both parties in its implementation. I would also like to express my gratitude to all of the staff and students at Tyndall for their fortitude and application during the most difficult of years.



Eoin O'Driscoll
Chairperson

Eoin O'Driscoll,
Tyndall Chairperson

UCC President,
Professor John O' Halloran
with An Taoiseach
Micheál Martin TD

CEO's message

2020 was quite an extraordinary year for Tyndall, as it was for Irish society and indeed the rest of the world. I am pleased to report that we successfully navigated the challenges presented by the Covid-19 pandemic and never had to close our doors completely.

This was made possible through the support of University College Cork leadership and by the Government's designation of research as an essential activity at a very early stage in the pandemic. That meant our labs were only fully closed for four weeks and all our researchers were able to undertake essential practical tasks from the start of June. That enabled us to maintain a relatively high level of research activity throughout the year.

Of course, our researchers had to adapt to different working patterns and worked from home whenever possible. This had its negative aspects. Scientific research and innovation thrives on the essential encounters between individuals working in close quarters. We have missed those unexpected interactions and their unpredictable outcomes and look forward to returning to a more normal pattern of work in the coming months.

While some of our projects were affected by the pandemic restrictions, we have received generous support from government through the Higher Education Authority to help support students and researchers with project extensions and we are very grateful for that.

We are also grateful for the continued support for our Tyndall 2025 Strategy shown by the Department of Further and Higher Education, Research, Innovation and Science and Minister Simon Harris TD.

Formally launched in January 2020, Tyndall 2025 was developed with the objective of doubling the size of the institute to become a more significant player on the international research stage and secure a global leadership position for Ireland in deep-tech research.

A key objective of the strategy is to increase our societal impact with Tyndall focusing more on using deep-tech R&D to address some of the most pressing issues facing the world today including the climate crisis, energy, clean water, healthcare, disease prevention and gender equality.

Despite the challenges presented by Covid-19, we have made great progress in the initial implementation of the strategy and continued to win prestigious funding awards for excellence in research, becoming one of the most successful institutes in Ireland and Europe for H2020 funding in ICT. We increased our collaboration with industry partners who are looking to avail of our deep-tech research expertise and state-of-the-art facilities. We currently engage with over 200 multinational companies and SMEs from across Ireland and internationally and facilitated the launch of a number of high potential spinout companies during the year.

We also increased our support for PhD and Masters students and, despite the complexities of the pandemic restrictions, we were recently joined by 40 new staff and students from across the world. There were also several new senior research appointments, including one of Europe's biggest stars in the area of Advanced RF Technologies, Prof. Dimitra Psychogiou as Professor of Microelectronics at UCC, and a global pioneer in Small Cell Technology for mobile networks, Prof. Holger Claussen.

These achievements were grounded on the three pillars of scientific excellence, economic and societal impact, and international success. Everything we do at Tyndall is about world class research excellence as exemplified by the ERC grant to UCC engineering academic and Tyndall PI Prof. Padraig Cantillon–Murphy for his research into revolutionising the future of surgery.

Our impact in critical areas such as climate change and energy was further enhanced during the year by the appointment of Prof. Brian Norton, a world leader in solar energy research, to lead the IERC at Tyndall.

Our international success is about more than just funding. Our international relationships are based on the excellence and relevance of our research and our thought leadership in deep-tech. Companies from around the world are interested in coming to work with us because of that.

Looking ahead, the pandemic has highlighted the importance of Tyndall's work. Technology and deep-tech have a critically important role to play in addressing some of the great challenges faced by society now and in the future and our objective is to ensure that Ireland is at the leading edge of scientific research in those areas.

In conclusion, I would like to express my gratitude to each and every one of our staff and students for their tremendous efforts during what was an exceptionally difficult and unusual year. Not only did we keep our doors open but we made significant progress in meeting our strategic objectives.

Professor William Scanlon
CEO

Scorecard

Research excellence

Dr Oskar Z. Olszewski and Dr Ruth Houlihan delivered novel silicon mesh devices for nebulisers to Irish medical company, Aerogen, a world leader in high performance aerosol drug delivery. A US patent application is currently being submitted

223 PUBLISHED PAPERS

€33m in research income

IPIC awarded the Irish MedTech Association Academic Contribution Award

UCC engineering academic and Tyndall PI Prof. Pádraig Cantillon-Murphy received an ERC Consolidator Award for magnetic tracking of surgical devices

Dr Lynette Keeney awarded a renewal of her Royal Society SFI University Research Fellowship *for her research on making memories: ultra-thin multiferroics for disruptive data storage technologies*

Impact

Research collaboration with Aerogen, a global leader in ICU aerosol drug delivery

SME SECTOR ACCOUNTED FOR **50% OF ALL** NEW INDUSTRY RESEARCH PROGRAMMES

5 **new ventures** launched under the direction of the newly appointed New Ventures Manager, Peter Finnegan

TOTAL VALUE OF NEW INDUSTRY RESEARCH PROGRAMMES WAS **€12m**

30 industry personnel from 5 partners took part in on-site industry funded training programmes

MCCI Phase 3 funded to 2025 (€10m)

Launch of Explorer deep-tech pre-accelerator programme

37 invention disclosures
17 licences, options and assignments
5 patents filed

International reach

LEADING FOUR NEW PROJECTS

in research infrastructures (ASCENT+), photonics (PhotonicLEAP), energy (UP STAIRS) and EIC Pathfinder (Nano EH)

EU programmes in numbers:

€710m total project value | *Tyndall involved in 10% of the total Horizon 2020 drawdown in Ireland* | 106 EU Projects | *46 projects in ICT*

New innovation Hub for photonic SMEs established

Tyndall researchers instrumental in the publication of 'More than Moore' white paper as part of the International Roadmap of Devices and Systems and particularly in the creation of a new chapter in Agri-food and Natural Resources

Established a new MedTech pilot line

EU programmes

18 new projects, bringing €12m in funding for Tyndall

People and culture

a research community of over 600 people

Celebrated John Tyndall's bicentenary through a series of virtual events

LAUNCHED A TYNDALL SCOUTING BADGE

Summer internship programme expanded to cover photonics and micro and nano systems

4,000 students and 7,500 members of the public participated in STEAM activities

Prof. Stefan Andersson-Engels featured in RTE's 10 Things to Know

Graduate Education

→132 PhDs, 14 Masters by research
→15 PhDs completed
→36% of all postgraduate students are women

Infrastructure

Strengthened our access programmes to make our state-of-the-art equipment available to academia and industry internationally

Established new Wireless Communications Lab in Dublin under the leadership of **Prof. Holger Clauseen**

ACCESS MAINTAINED TO ALL LABS DESPITE COVID-19 RESTRICTIONS

The Tyndall Catalyst programme expanded internationally with a new collaboration with the Institute for Materials Research at The Ohio State University

Tyndall National Institute

Research excellence

Dr Oskar Z. Olszewski and Dr Ruth Houlihan delivered novel silicon mesh devices for nebulisers to Irish medical company, Aerogen, a world leader in high performance aerosol drug delivery. A US patent application is currently being submitted

223 PUBLISHED PAPERS

€33m in research income

IPIC awarded the Irish MedTech Association Academic Contribution Award

UCC engineering academic and Tyndall PI Prof. Pádraig Cantillon-Murphy received an ERC Consolidator Award for magnetic tracking of surgical devices

Dr Lynette Keeney awarded a renewal of her Royal Society SFI University Research Fellowship ***for her research on making memories: ultra-thin multiferroics for disruptive data storage technologies***

Professor Dimitra Psychogiou

During 2020 we made significant advances in our plans to grow our research activities and capabilities, substantially increase our impact, our enterprise engagement and our international competitiveness. This was evidenced in the recognition achieved by individual researchers as well as in the appointment of senior research leaders.

Tyndall's research excellence was recognised this year with a number of significant individual research awards. These included a European Research Council Consolidator award for Prof. Pádraig Cantillon-Murphy from the School of Engineering in UCC, as well as the renewal of Dr Lynette Keeney's Royal Society SFI University Research Fellowship, and the award of a Marie Curie International Fellowship for Dr Pietro Pampili to visit Nagoya University (Japan) for two years. IPIC, the SFI Centre for photonics, also received the Irish MedTech Award for Academic Contribution.

We were also honoured to see Tyndall CEO, Prof. William Scanlon, selected as a Fellow of the Institute of Electrical and Electronics Engineers for his contributions to antenna design for wearable and implantable applications.

Prof. Brian Norton's appointment as head of the IERC brings to Tyndall both his leadership in energy research as well as his wider experience as former President of Technological University Dublin, while the recruitment of Prof. Dimitra Psychologiou as Professor of Microelectronics at UCC and of Prof. Holger Claussen and his team from Nokia Bell Labs to Tyndall Dublin offer major new opportunities in radio frequency (RF) and wireless technologies.

The research highlights presented over the following pages reflect our mission to tackle major societal challenges through significant advances in scientific and engineering research, from atoms to systems. The research outputs featured range from fundamental theoretical analysis targeting efficient thermoelectric components through smart approaches to vibrational energy harvesting, enhanced brightness quantum dot LEDs and a novel bio-photonic application for early cancer detection.

Professor Holger Claussen

Pushing the boundaries of quantum technologies

Quantum dots have proven to be exceptionally reliable sources of single and entangled photons that could lie at the heart of future photonic quantum technologies but progress in the field has been hampered by the absence of a versatile technique that would allow the fabrication of complex nanofeatures in their proximity.

In a study, conducted in collaboration with the University of St. Andrews (UK), we have proven that Electron Beam Induced Deposition can be the missing link the community has been seeking to successfully fabricate 3D structures directly on top of individual quantum emitters.

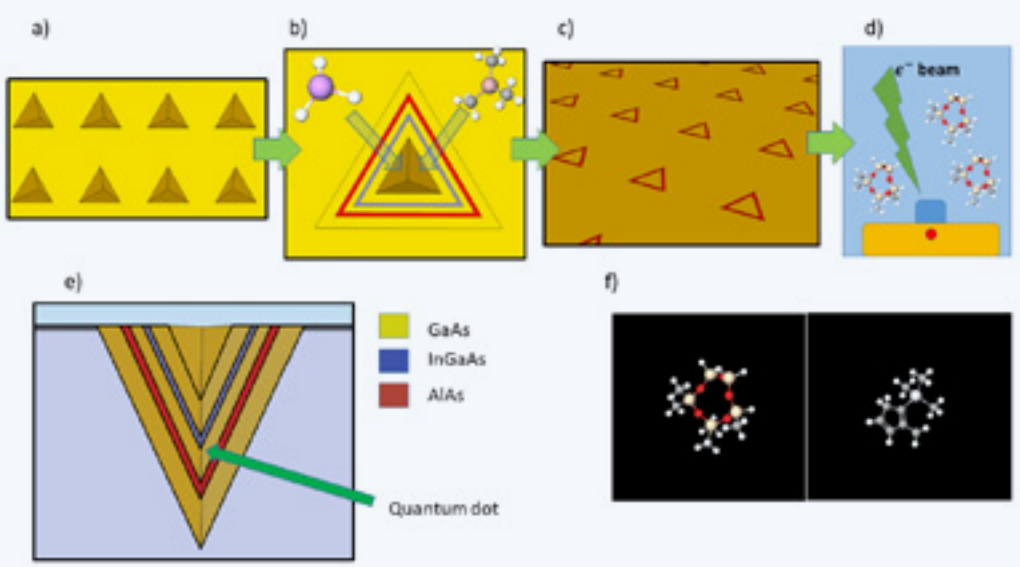
Significant increases in light extraction efficiency have been reported, but the most striking feature of the technique was pristine preservation of the quantum dot structures during the fabrication. This can be attributed to the additive nature of our approach.

ACS Applied Nano Materials

https://doi.org/10.1021/acsanm.0c02969

Simone Varo; Xin Li; Gediminas Juska; Iman Ranjbar Jahromi; Agnieszka M. Gocalinska; Andrea Di Falco; Emanuele Pelucchi.

Representation of the steps in the fabrication of the samples: a) patterning of the substrate; b) MOVPE growth, organometallic precursors dissociate preferentially on the three exposed 111A faces; c) planarization; d) EBID growth; e) cross section of the structure after MOVPE growth. The QD is formed by enclosing a thin InGaAs layer between two GaAs barriers. f) EBID precursors PMCPS (left) and (Me3)MeCpPt (right)



Increasing the efficiency of thermoelectric devices

Thermoelectric devices are reliable, long-lived, environmentally sustainable solutions for low power generation. They use excess heat from the environment and convert it into electrical power. However, current thermoelectric devices have low efficiency, do not scale very well (efficiency further drops if one tries to make them smaller), and often use highly toxic materials like lead.

To overcome these issues, we proposed a new thermoelectric device design based on ferroelectric domain walls of germanium telluride. Ferroelectric domain walls are structures naturally occurring in ferroelectric materials that separate regions with differently oriented polarisation.

The polarisation change that happens at the ferroelectric domain walls can lead to the confinement of free charge carriers, electrons, and holes. Using first-principles calculations, we showed that this confinement induces a stronger energy dependence of free charge carriers' transport properties.

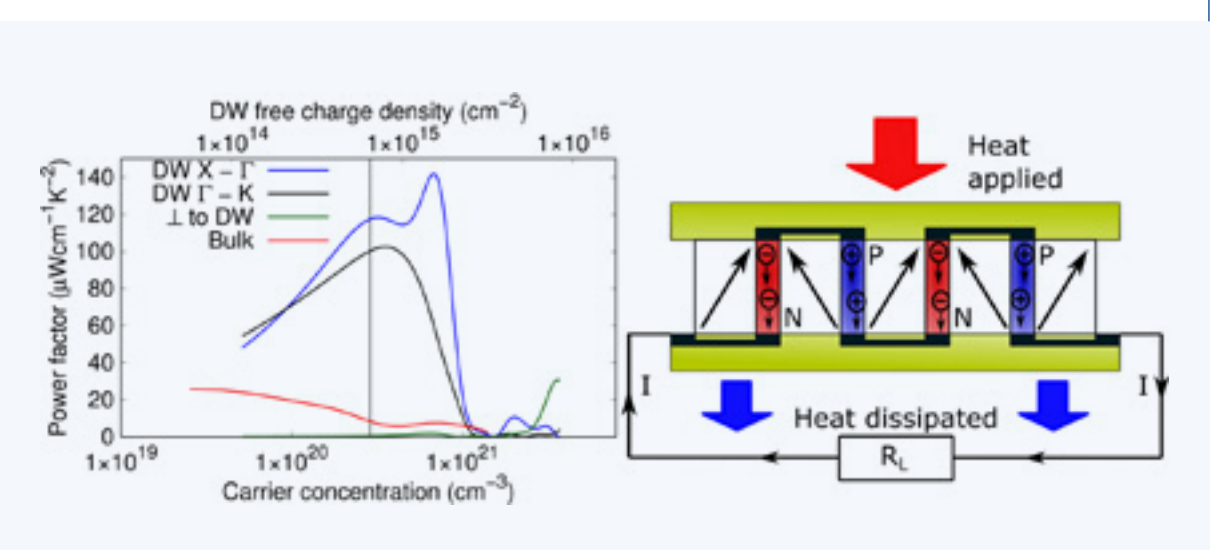
This leads to a five-fold increase of the thermoelectric power factor which determines the efficiency of the material. Additionally, the size of ferroelectric domain walls is of the order of one hundred nanometres, which makes them a promising solution for powering microelectronic devices.

npj Computational Materials

https://doi.org/10.1038/s41524-020-00468-3

Đorđe Dangić; Stephen Fahy; Ivana Savic

Thermoelectric power factor of charged ferroelectric domain walls and proposed design of the nano-thermoelectric device based on domain walls



A new non-invasive tool for early colorectal cancer detection

Colorectal cancer (CRC) is the third most common type of cancer worldwide and the second most deadly. Preventing deaths by CRC requires accurate and early detection as well as complete removal of the cancer during surgery.

Researchers at the Biophotonics team at Tyndall and IPIC the SFI Research Centre for Photonics have developed a non-invasive tool for early CRC detection. The tool uses the intensity of reflected light to sense and differentiate biological tissues more precisely and faster than conventional methods.

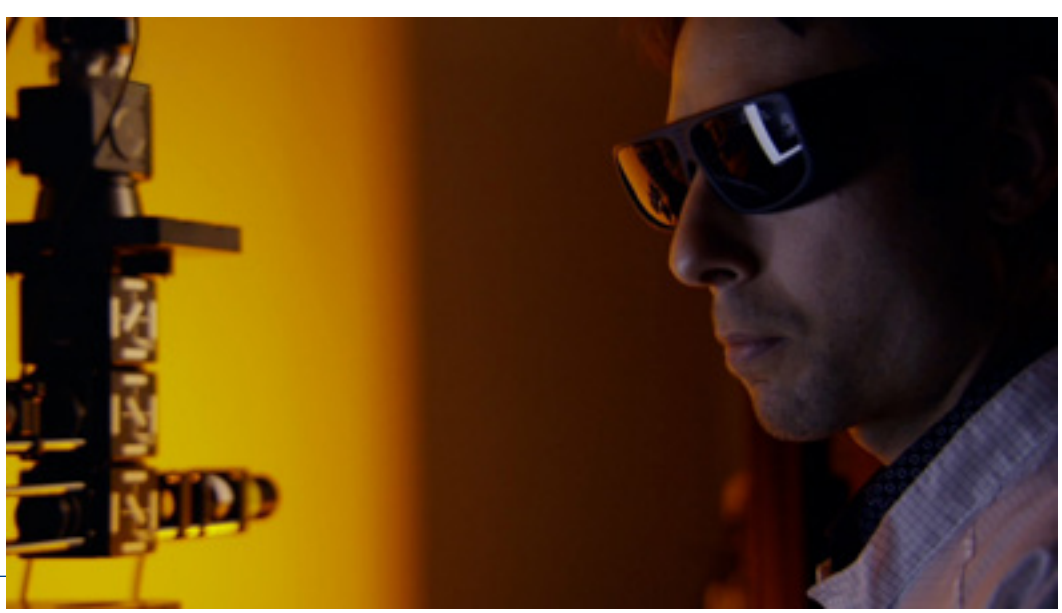
In collaboration with clinicians at Mercy University Hospital Cork, researchers have investigated instrument specifications and machine learning methods for accurate tissue identification. These specifications included the collection of a larger range of light colours and probe geometry, which enabled the study of superficial and deeper tissues, as well as a greater variety of tissue microstructures and biochemical constituents of such tissues. To identify tissues in real-time, a robust machine learning model was built based on a database comprising 7.5 times more measurements than previous studies.

Very importantly, the new biophotonics technology is both cost-effective and capable of being integrated into existing medical tools.

Scientific Reports

https://doi.org/10.1038/s41598-020-79517-2

Marcelo Saito Nogueira; Siddra Maryam; Michael Amissah; Huihui Lu; Noel Lynch; Shane Killeen; Micheal O'Riordain; and Stefan Andersson-Engels



Researchers from the Biophotonics team at Tyndall and IPIC the SFI Research Centre for Photonics have developed a non-invasive tool for early CRC detection

Developing a perpetual power supply for Internet of Things sensors

The major barrier to the widespread deployment of wireless sensor nodes in Internet of Things (IoT) networks is the lack of a perpetual power solution to replace energy limited batteries. Tyndall, in a collaboration with the School of Mathematical Science in UCC, is working on finding a reliable solution to this issue.

We demonstrated a wideband and high-power density nonlinear vibration energy harvester with novel tapered spring architecture that outperforms many contemporary energy scavengers.

The fabricated nonlinear device has been demonstrated to be capable of powering a wireless sensor node that reports on vital physical parameters such as humidity and temperature, thereby enabling a resilient remote data acquisition system. This demonstrates the potential of our design to provide a sustainable energy source for a wide range of IoT platforms.

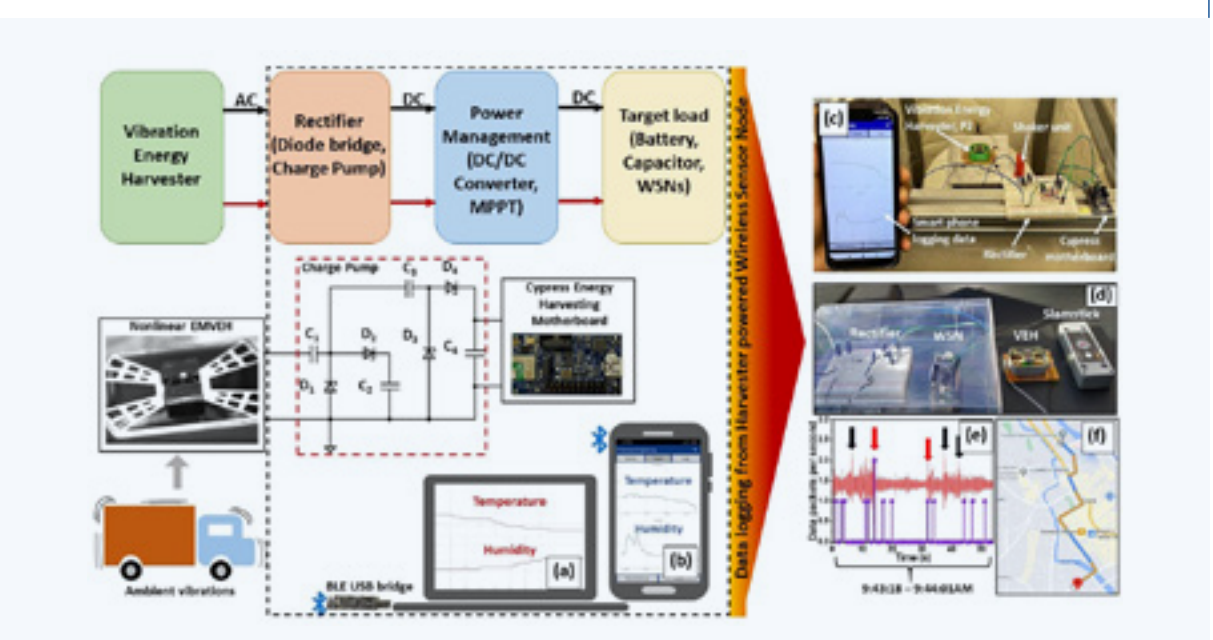
This opens up the possibility of replacing batteries by establishing a resilient self-powered network of tiny sensor nodes. Such a network could be used for continuous in-situ monitoring of food or medicinal products during transit from manufacturer to distributor.

Applied Energy

https://www.sciencedirect.com/science/article/pii/S0306261920316573

Kankana Paul; Andreas Amann; Saibal Roy

Schematic illustration of the complete vibration energy harvesting unit powering a wireless sensor platform allowing data recording through (a) laptop and (b) smart phone. (c) Continuous data logging from the temperature and humidity sensor through smart phone harvesting energy from laboratory shaker unit. (d) Powering of wireless sensor platform with the vibration energy harvester scavenging energy from vibrations of a car, (e) shows the vibration profile and rate of acquiring data, (f) shows the path that the car followed while the data was recorded




Aeroneb Solo

Impact

Tyndall's success in industry engagement is built on our leading research teams collaborating on-site with deeply embedded industry partners. Despite the uncertainty created and the restrictions imposed by Covid-19, the total value of new industry projects confirmed in 2020 was €12m across 75 individual research and support programmes of which 50% were with our SME partners.

When measured against the industry impact milestones set out in our Tyndall 2025 strategy, we met the targets for SME research collaborations, long-term collaborative research engagements and grew our cohort of industry Researchers-in-Residence on-site to over sixty. In addition, targets for industry personnel trained and New Ventures created (start-ups, spin-ins and spin-outs) were exceeded by 30%.

The Covid-19 pandemic inevitably impacted our on-site activity for industry engagement, both for programme delivery and industry access to our critical research infrastructure. However, as was seen across many sectors of the community, we were supported by our outstanding Health and Safety, Operations, Facilities and dedicated delivery support teams who ensured that we could proactively support the safe continuation of technology research as an essential economic activity. We are grateful to all of our industry partners who worked with us to ensure a safe environment for everyone. Together we created the best environment for the essential ramp in economic activity when circumstances permit.

Technology transfer

RESEARCH COMMERCIALISATION

37 Invention Disclosure Forms

5 Patents filed

12 Licences Options and Assignments (LOAs) with partners

5 technologies had patents granted

INDUSTRY ENGAGEMENT

New industry programme funding to Tyndall:

€12m

over 75 individual engagements

50% of industry engagement with SMEs

25% of new industry engagements with Health and Life Science industy partners

Tyndall partnered with Intel and SFI AMBER on '3D Composite Core Inductors Integrated into Package' project, making new novel magnetic composite materials for package-integrated inductors

Talent pipeline

50% ***of Tyndall early-stage New Ventures continued actively recruiting though the pandemic***

Expanded focus on talent pipeline development, growing industry funded training programmes **– with over 30 participants from 5 different companies**

High-value start-ups/New Ventures

EXPANSION OF THE NEW VENTURES PROGRAMME WITH THE APPOINTMENT OF PETER FINNEGAN, NEW VENTURES MANAGER, IN JULY 2020

ESA Space Solutions Centre Ireland Consortium Partnership expanded with the addition of Dublin-based NovaUCD

5 NEW VENTURES LAUNCHED

Spin-out: BioPixS

Spin-ins: Radiant Oximetry Ireland & X Display

Start-up: SMART Edu Club

Incubation client: waytoB

Launch of the industry-funded Explorer Deep Tech Pre-Accelerator Programme by partners IPIC, Tyndall, Osram and IQE with a strategic link to the EU supported IPCEI (Important Projects of Common European Interest) in Microelectronics. Explorer supports the emergence of next-gen deep-tech based start-ups

Launch of the New Ventures Fire Side Chat Series with deep-tech entrepreneurs including Carl Jackson of Tyndall spin-out SensL (acquired by On Semiconductor)

Tyndall spin-out BioPixS secured

€700K IN EU FUNDING

Dr Sanathana Konugolu Venkata Sekar, Biophotonics Group, developing tissue phatoms for biomedical testing

Bank of Ireland Deep Dive funding awarded to ***Tyndall SLED project for commercialisation***

Covid-19 focussed start-up PMask Ltd supported through Tyndall New Ventures

Talent pipeline

MCCI transferred 10 researchers to industry, bringing MCCI Alumni to almost 70 with 70% Irish based

Analog Devices sponsored and judged the 8 finalists for the Postgraduate Research Publication of the Year

World leading integrated magnetics research

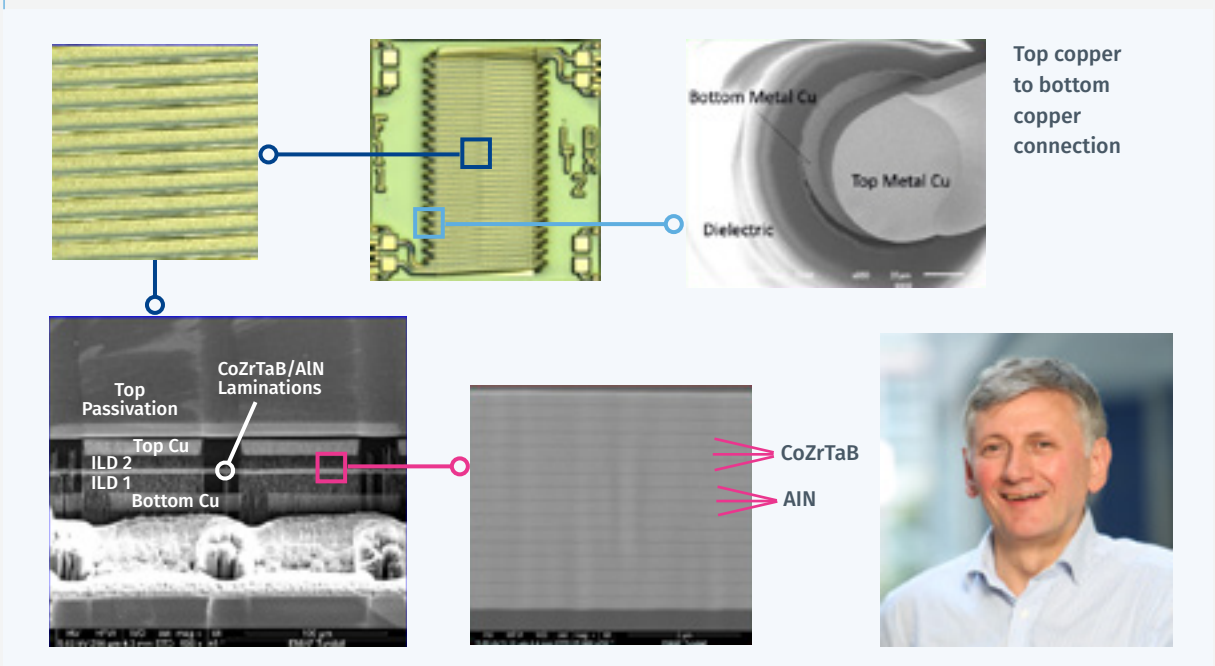
The Integrated Magnetics group at Tyndall, led by Dr Paul McCloskey, continues to go from strength to strength, and is now recognised as global thought leaders in driving international research and commercialisation of integrated magnetics.

Integrated magnetics delivers dramatic reductions, up to ten fold, in inductor component height, footprint and cost. It also delivers a reduction in energy consumption in many applications of more than 50%. This in turn reduces data centre power requirements, thereby delivering a huge impact by providing an additional solution for one of the greatest challenges facing society, energy production.

Additional impact from the group includes the transfer of skilled researchers to three leading MNCs both in Ireland and overseas, helping to drive industry-wide adoption of this Tyndall technology. Based on the current status of materials and semiconductor process characterisation in commercial foundries and technology productisation licenses signed with global application partners, we expect foundry qualification to be complete in 2021/2022.

The team has also had funded collaborations with more than 16 world-leading companies and co-authored journal and conference publications with many institutes and international companies including Intel, Texas Instruments, AT&S, Bosch, Global Foundries, IBM, Infineon, MuRata/IPDiA and Würth Elektronik. In addition, the team had a joint patent granted with Apple in 2019. Licensing and research income of more than €10m continues to provide the resources necessary to remain at the leading-edge of this ground-breaking technology.

FIB cross-sections of integrated transformer with Dr Paul McCloskey inset



Research collaboration agreement with aerogen

This collaboration combines our strong expertise in deep-tech ICT for medical health applications with Aerogen's world leading capability in the design, manufacture and marketing of aerosol drug delivery systems. The company's transformative aerosol technology is used to treat patients on life support ventilation in Intensive Care Units (ICUs) in 75 countries. Aerogen products have been instrumental in helping patients worldwide to recover from Covid-19.

The Enterprise Ireland funded project aims to improve the efficacy of pulmonary drug delivery systems in ICUs. The two-year project is focused on the redevelopment of a mechanical component used to nebulise pulmonary drugs from liquid form into an aerosol of tiny droplets capable of being inhaled directly into a patient's lungs.

"Tyndall's track record of delivering engineering innovation in commercial research will help us pioneer next generation solutions in critical care settings" explained Dr Ronan McLaughlin, Senior Science Manager at Aerogen.

Aerogen nebuliser

International reach

LEADING FOUR NEW PROJECTS

in research infrastructures (ASCENT+), photonics (PhotonicLEAP), energy (UP STAIRS) and EIC Pathfinder (Nano EH)

EU programmes in numbers:

€710m total project value | *Tyndall involved in 10% of the total Horizon 2020 drawdown in Ireland* | 106 EU Projects | *46 projects in ICT*

New innovation Hub for photonic SMEs established

Tyndall researchers instrumental in the publication of 'More than Moore' white paper as part of the International Roadmap of Devices and Systems and particularly in the creation of a new chapter in Agri-food and Natural Resources

Established a new MedTech pilot line

EU Programmes
18 new projects,
bringing €12m in funding for Tyndall

2020 has been a highly successful year for our EU Programmes and our overall international activities, with considerable progress made towards achieving the Tyndall 2025 goal of becoming an international research partner of choice.

Through engagement in Europe and globally, our thought leaders have made significant contributions to research policy publications and major roadmaps in areas such as materials, devices and systems and their integration into innovative solutions.

Tyndall researchers have been instrumental in the publication of the 'More-than-Moore' White Paper - part of the International Roadmap of Devices and Systems (IRDS) - and in the creation of a new chapter on Agri-food and Natural Resources in the fully revised strategic research and innovation agenda of Electronics Components and Systems ECS-SRIA 2021 which underpins Key Digital Technologies in Horizon Europe.

Our success during 2020 reinforced Tyndall's leadership in ICT and our contribution to UCC's position in the top five ICT-funded universities in Europe.

During the year, 18 new projects were funded, bringing €12m in funding to Tyndall. Four large-scale multi-partner projects are led by Tyndall researchers, including one first time coordinator. These initiatives address access to infrastructure for nanoelectronics, photonic wafer-level integration, smart materials for energy harvesting in IoT, and sustainable energy business models and policy.

We also celebrated Prof. Pádraig Cantillon-Murphy's European Research Council award for ground-breaking imaging technology for medical devices.

Other EU projects kicking-off include major initiatives on setting up an innovation hub for photonic SMEs and a MedTech pilot line, and five high-risk game-changing projects sponsored by the European Innovation Council in the areas of energy-efficient ICT, plasmonics, spintronics and neuromorphic computing.

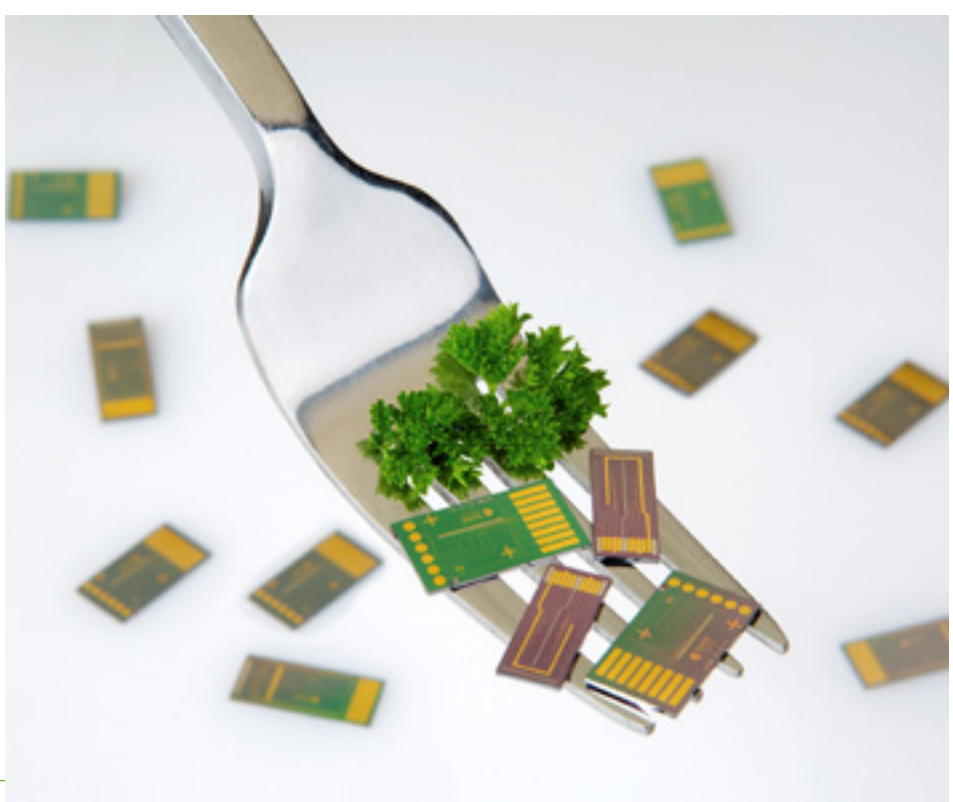
Our international activities offer expertise and access to infrastructure for SMEs while addressing global challenges in health, agri-food, the environment, and energy.

Thought leadership

Tyndall researchers co-authored a White Paper on ‘More-than-Moore’ which has been released by the International Roadmap for Devices and Systems (IRDS).

The purpose of the IRDS is to identify technical challenges that need to be addressed to ensure microelectronics remains a driver for innovation across a wide range of applications. The White Paper establishes a new chapter in the IRDS, reflecting the critical shift that has taken place in microelectronics innovation.

Whereas previously the industry has been primarily technology driven thanks to Moore’s Law, it is now increasingly driven by application requirements. Rather than a focus on chips and a one size fits all scenario, the new approach centres around ‘systems’ and the production of devices that are agile and fit for use in a variety of different applications. This is the era of ‘More-than-Moore’ and the White Paper covers the areas of Smart Sensors, Smart Energy, Energy Harvesting, and Wearable, Flexible and Printed Electronics.



New chips, devices and smart systems being developed at Tyndall are essential to ensure sustainable and secure Agri-food production into the future

Strategic partnerships

The Photonics Packaging Group at Tyndall is leading a number of collaborations with research organisations around the world to develop and promote packaging standards and to organise new education programmes in photonics.

Through our leadership of the European Photonics Packaging Pilot Line, PIXAPP, we formed a collaboration with researchers at AIM Photonics. AIM Photonics is a large-scale US consortium developing advanced integrated photonics technologies, from photonic device design and fabrication through to packaging and testing.

Working with AIM Photonics researchers at SUNY Institute and University of Rochester in New York, we developed standardised photonic devices which are compatible with standardised packaging processes. These devices enable faster and more cost-effective packaging processes, leading to increased uptake of integrated photonics in markets such as communications, medical devices, quantum technologies and sensors.

Furthermore, through our leadership of the new European Photonics Academy, we led the roll-out of 50 state-of-the-art photonics training centres across Europe. This exciting initiative enables Tyndall to lead photonics education and training programmes at a global level. This includes the establishment of partnerships with leading US education institutes such as MIT, where the packaging group at Tyndall and MIT researchers received a MISTI Global Seed Fund award to enable exchanges between PhD students and researchers at both institutes.

Professor Peter O'Brien and PhD student Parnika Gupta with recently installed FiconTEC CL1500 photonic packaging system

Large scale initiatives

EnABLES is a four-year access programme, funded by Horizon 2020 and led by Tyndall, which is building a 'power IoT' community around a €2bn research infrastructure, incorporating Energy Harvesting, Energy Storage, Micro-Power Management and System Integration.

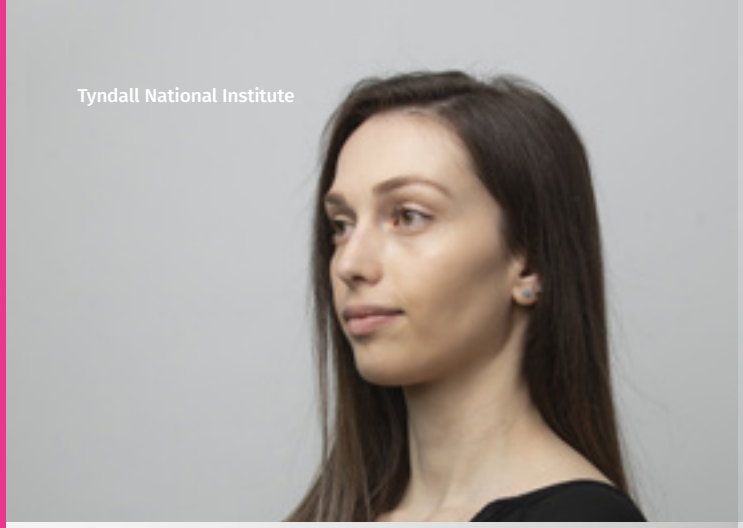
Since July 2018, the four research institutes involved (Tyndall, CEA Leti/Liten, Fraunhofer IIS/IMS, and imec) received more than 100 'transnational access' feasibility study requests, offering funded access to expertise and infrastructure. These projects seed and accelerate the development of solutions to extend battery life of wireless IoT edge devices, ideally making them outlive the devices they power.

These institutes along with five knowledge hubs (POLITO, KIT, Universities of Perugia, Bologna & Southampton) also undertake joint research activities to develop future transnational access offerings focusing on system optimisation, standardisation and inter-operability.

Some 497 stakeholders from 39 countries have subscribed and 42 transnational access feasibility studies are already underway.

Reaction to EnABLES has been extremely positive, with many citations of the project's excellent and impactful research outputs. A position paper has been published which asserts the need for these outputs to be leveraged further with long battery-life wireless IoT devices representing a significant challenge and opportunity for the EU to meet its 2030 Green Deal objectives.

Dr Giorgos Fagas, Head of EU Programmes and Mike Hayes, EnABLES project coordinator


Tyndall National Institute

People and culture

a research community of over 600 people

4,000 students and 7,500 members **of the public participated in STEAM activities**

Celebrated John Tyndall's bicentenary through a series of virtual events

LAUNCHED A TYNDALL SCOUTING BADGE

Prof. Stefan Andersson-Engels featured in RTE's 10 Things to Know

Summer internship programme expanded to cover photonics and micro and nano systems

Graduate Education

→132 PhDs, 14 Masters by research
→15 PhDs completed
→36% of all postgraduate students are women

We started 2020 on a high with the launch of the Tyndall 2025 Strategy, which sets out an ambitious roadmap to build on almost 40 years of success in deep-tech information and communications technology research. The five-year strategy represents a shift in Tyndall's focus towards addressing the world's major societal challenges.

In keeping with our goal of attracting and nurturing the best talent, we successfully launched the Tyndall Early Career Researchers Network (TEC-Net) with the goal of fostering our future research leaders. We also celebrated our post-graduate students as they showcased their research excellence in the 2020 Postgraduate Paper Competition.

We were proud to be able to nominate and celebrate Tyndall Alumni and Board Member Dr Ann Kelleher's achievement in being awarded Science Foundation Ireland's (SFI) prestigious St Patrick's Day Science Medal at a ceremony in Washington, DC. The Medal recognises Dr Kelleher's outstanding expertise and support of research in Ireland.

Everything changed abruptly for us all in early 2020 with the arrival of Covid-19 to our shores and as a community of researchers, students, staff, carers, parents and people, we rallied together to navigate a somewhat uncertain time.

Despite the challenges presented by the Covid-19 restrictions we managed to continue to attract the best talent with the opening of a new lab in Dublin focussed on future communication technologies for IoT, Wi-Fi, 6G, artificial intelligence and quantum systems. Tyndall's Wireless Communications Research Laboratory is headed up by industry thought leader and acclaimed scientist Prof. Holger Claussen, along with Dr Lester Ho and Dr Senad Bulja.

In conjunction with UCC, we announced the appointment of Prof. Dimitra Psychogiou, a global expert in Radio Frequency front-end technologies, to the position of Professor of RF Microwave Communications in UCC's School of Engineering and Head of Advanced RF Technologies Research at Tyndall.

An expanded programme for summer internships within Tyndall was delivered remotely in response to Covid-19 restrictions with women making up 60% of the participants.

PhD vivas 2020

Thanih Balbaied
Development of microelectrode arrays for real-time monitoring of Alkaline Phosphatase release from cells in clinical analysis

Uday Bangavadi Munivenkatapa
Dynamics of a swept source laser under external injection

Vuslat Buk Juska
Design, development and characterisation of nanostructured electrochemical sensors

Sharon Butler
Wavelength swept photonic crystal laser

Stefano Facchin
A silicon photonics receiver for multi-level signalling in short-reach interconnects

Emmanuele Galluccio
GeSn semiconductor for micro-nanoelectronic applications

Amandeep Kaur
Tb/s Superchannels for optical communications

Gioele Mirabelli
Two-dimensional semiconductors for future electronics

Edmond O'Halloran
Theory of the electronic and optical properties of group-IV alloys

Shane O'Mahony
Electronic excitation and atomic forces in optically excited group V semimetals

Alison Perrott
Mutually coupled lasers on a photonic integrated circuit

Caoimhe Robinson
Development of on-farm diagnostic devices

Louise Ryan
Atomic layer deposition of metal oxides for photovoltaic applications

Ian Seymour
Nanowire and microband arrays for enhancing electrochemical sensing

Kevin Shortiss
Optical comb injection for optical demultiplexing and harmonic frequency locking

Education and public engagement

Public engagement is of the utmost importance for higher education and scientific research. This helps create awareness of the importance of science for society and builds public trust in the research ecosystem.

One of the highlights of 2020 was Invisible Light, where art met science in an expansive new exhibition from The School of Looking at the Crawford Art Gallery. Funded by SFI Discover Programme, this reignited the gallery's heritage as an institution for both artistic and scientific endeavour.

Marking the bicentenary anniversary of the birth of visionary Irish scientist John Tyndall (1820-1893) and encompassing Science Week 2020, artists Anne Cleary and Denis Connolly from The School of Looking worked closely with scientists from Tyndall and IPIC, and curators at Crawford Art Gallery to imagine an exhibition that truly united art and science.

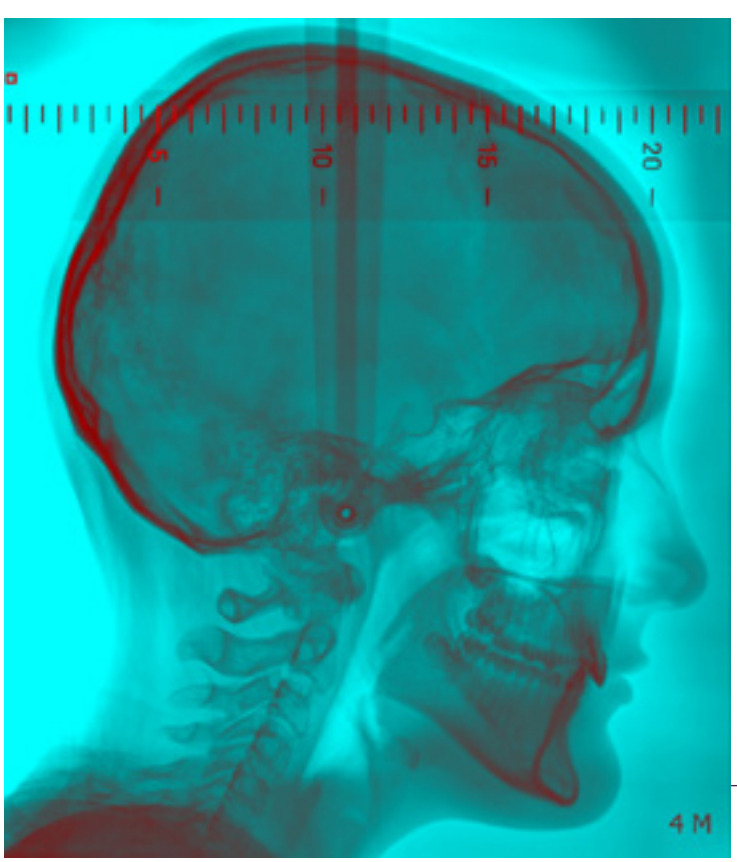
The exhibition featured seven newly commissioned artworks with each exploring a region of the electromagnetic spectrum. The artworks were accompanied by seven weekly Ray Days, days of safe public engagement dedicated to each separate type of electromagnetic waves.

The bicentenary was also marked through a series of inclusive bicentennial activities that were celebrated online and around the world. The Bicentennial Celebrations #Tyndall200 included:

- I Know Why the Sky Is Blue, Do You? A livestream broadcast by Carlow County Museum with Julie Donelly of Tyndall and renowned expert on John Tyndall Sir Roland Jackson amongst others.
- Tyndall Science at Home featured a series of experiments presented by Tyndall researchers and their families for children and adults to replicate at home.
- The Tyndall Scouting Badge was launched with Scouting Ireland to recognise John Tyndall's extraordinary contribution to science, education and the environment.
- In continued celebration of the bicentenary, the Royal Institution hosted a special lecture with Tyndall scientist Prof. Paul Hurley.

Orla O' Sullivan, Ronan Crowley and Scout Leader Lee Barry of 97th Cork Innishannon Scouts at the launch of the Scouting Ireland Tyndall Badge, created in partnership with Tyndall National Institute in celebration of Irish scientist John Tyndall's 200th birthday

John Tyndall FRS



INVISIBLE LOOKING by the School of Looking at the Crawford National Gallery

Tyndall National Institute

Infrastructure

Strengthened our access programmes to make our state-of-the-art equipment available to academia and industry internationally

ACCESS MAINTAINED TO ALL LABS DESPITE COVID-19 RESTRICTIONS

Established new Wireless Communications Lab in Dublin under the leadership of **Prof. Holger Clauseen**

The Tyndall Catalyst programme expanded internationally with a new collaboration with the Institute for Materials Research at The Ohio State University

Dr Graeme Maxwell and An Taoiseach Micheál Martin TD in the Electron Beam Lithography Lab

Our state-of-the-art infrastructure provides a national research platform to develop the next generation of scientists and engineers from a national and international pool of talent. It is also a critical resource for companies seeking to innovate and increase competitive advantage internationally.

In 2020, we maintained our position at the leading edge of research addressing existing and emerging technological challenges. The facilities and tools we installed during the year are already driving new research opportunities with industry partners, as well as enabling us to increase our competitiveness in winning EU and European Space Agency (ESA) funding. We also strengthened our access programmes to make this state-of-the-art equipment available to internal and external academic and industry users both in Ireland and overseas.

In early 2020, we were forced to swiftly change working practices and close much of the facility due to restrictions imposed following the onset of the Covid-19 pandemic. We moved quickly to develop protocols to enable us to safely reopen the facility and laboratories.

This involved establishing procedures and protocols for the safe use of the laboratories as well as the necessary monitoring and tracking of access. Additionally, significant changes to the access routes, laboratories and shared spaces were required and we also put the necessary sanitisation stations, signage and PPE in place.

This enabled us to reopen the labs to researchers and commercial partners within a month, with all labs able to safely operate while complying fully to Covid-19 guidelines.

Tyndall also shared this experience with other third level facilities in Limerick and Dublin and supported them in defining the protocols and procedures they needed to reopen their facilities.

New developments

During the year, we made significant progress on a number of important pieces of new infrastructure.

Packaging Pilot Line

A new lab facility for the Disruptive Technologies Investment Fund (DTIF) funded photonics packaging pilot line is now complete and the first FiconTEC equipment has been delivered and installed.

Transfer Printing (TP) Pilot Line

TP equipment supplied by X-Celeprint is ready and will be installed in the existing Photonics Packaging Lab.

Coherent Communications Testbed

The SFI funded Testbed was commissioned in 2019 and has been further developed to enable up to 64GBaud system test and Matlab/Python VPI co-simulation and lab testbed control.

Cobotics

A Universal Robots UR16e collaborative robot (cobot) was purchased for research on industrial and collaborative robotics, teleoperation, VR/AR apps, autonomous, and robot navigation systems.

CryoCMOS

A cryogenic refrigeration capability for circuits research was acquired during 2020.

An Taoiseach Micheál Martin TD
and Professor William Scanlon, CEO

Catalyst programme

Despite Covid-19 restrictions, we were once again able to open a call for the Catalyst program for researchers. The Catalyst Award scheme has been running since 2017 and provides seed funding to enable the researcher to generate results and prototypes to enable proposals to be generated for projects that otherwise would not happen. The intention is to create a pipeline of new project ideas or research directions that go beyond a desk study and generate proof of concept results that can lead to funding success with an expectation for a follow-on project within 12 months of completion.

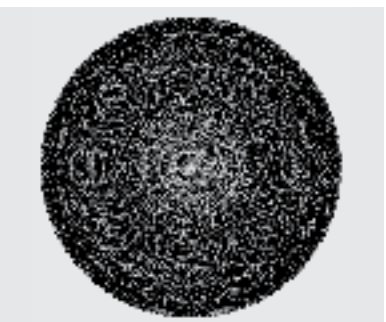
In 2020, we saw a high level of interest in the award, and following the project review, grants were awarded to six early-stage researchers who now have an opportunity to own and manage what may be their first solo project.

The success of this programme has led Tyndall to join with the Institute for Materials Research (IMR) at The Ohio State University, one of the top-20 public universities in the US, on a joint Catalyst Award. The goal of the award is to stimulate new projects and accelerate results in areas which build on the complementary assets of both institutes. Each Catalyst research team consists of two principal investigators with complementary expertise, one from each institute. Two projects were supported under the new joint programme in 2020.

Dr Lynette Keeney Catalyst Project, probing factors influencing multiferroic behaviour using direct detection electron energy loss spectroscopy

Scientific image competition winners

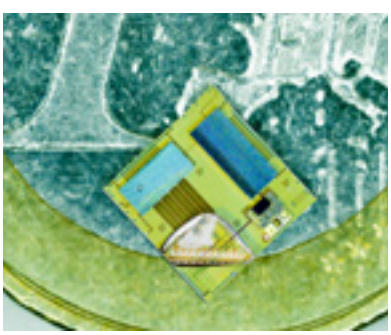
We would like to thank Elionix for their continued sponsorship of the Tyndall Scientific Images Competition where Tyndall researchers share scientific images to compete for a prize.



Oculus

Daniel Smallwood, Integrated Magnetics Electrochemical Materials and Energy

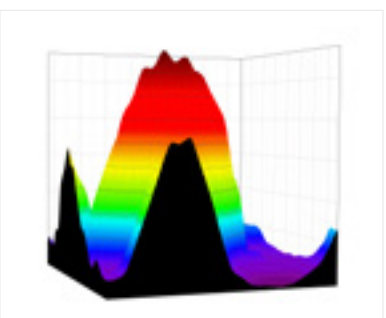
This mesmerising image captures the diffraction pattern from a circular photomask occulter, with UV light rays propagating according to the Huygens-Fresnel principle. This exemplifies monochromatic light, wherein the time domain is neglected and additionally, the z-dimension has been projected into x-y space. This phenomenon is observed in photolithography, which is essential for high aspect ratio photoresist relief image fabrication. This work is part of the SFI ADEPT project, Advanced Integrated Power Magnetics Technology - From Atoms to Systems.



Datacom PIC Assembly on Euro Coin

Ivan-Lazar Bundalo, Photonics Packaging

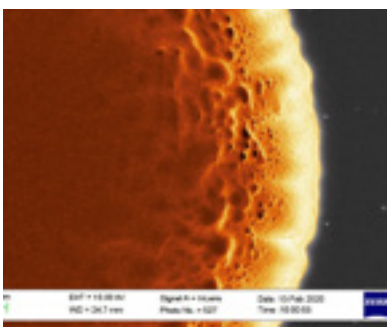
This Photonic Integrated Circuit (PIC) is the "heart" of a Datacom Transceiver, developed within the PIXAPP project. Integrated on top of the PIC are: Two Highspeed EICs for modulation and demodulation of optical signal (top), a laser, ball lens and prism on micro-optical sub-assembly (right), and micro-lenses for relaxed-tolerance optical coupling to/from the PIC (bottom). This complex assembly and integration was done at 4 different locations in Europe.



Magnetic Crown

Arindam Samanta, Micropower and Nanomagnetic

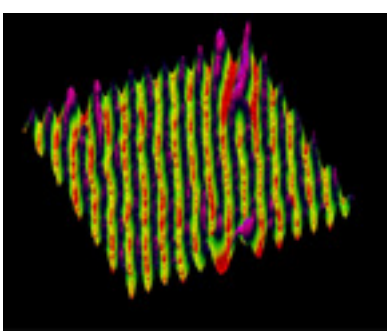
This is the top surface of electroplated amorphous cobalt phosphorus magnetic thin film, which could be very useful for inductor core and planar.



Vulcan

Daniel Smallwood, Integrated Magnetics Electrochemical Materials and Energy

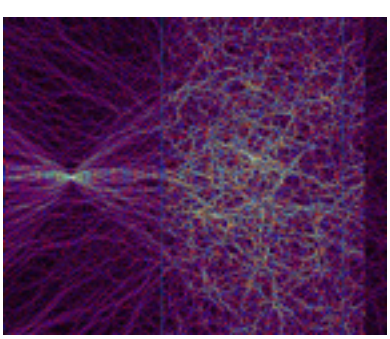
Through the lens of the SEM, we glimpse the rippled surface of an etched photoresist Cu pillar micromould. When coloured in vibrant orange and yellow, the micromould appears to warp across time and space and morph into the fiery planet Kepler10b. Once suggested to be unofficially named "Vulcan" after the hypothetical planet, this exoplanet is located a staggering 560 light-years from Earth. These micromoulds enable vertical interconnect access points (VIAs) for next generation MEMS devices with 2.5D and 3D System on Chip (SoC) and System in Package (SiP) applications. This technology is expected to hold great promise in spearheading the future of the microelectronics industry. Spock himself would be proud! This work is part of the SFI ADEPT project.



Magnetic Maze

Arindam Samanta, Micropower and Nanomagnetic

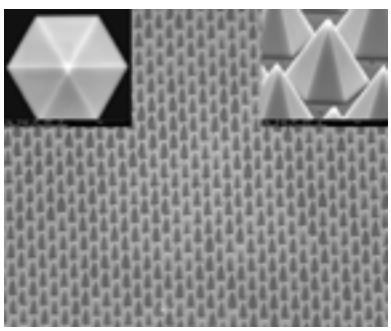
In reality this maze reveals the magnetic domains with multi-colour contrasts which are the self-organisation of magnetisation into alternating magnetised upward-downward nano-areas to form straight, parallel, and evenly spaced stripe domains by breaking the system into a multi-domain state.



Wave Focusing through Disorder

Michael Raju, Biophotonics

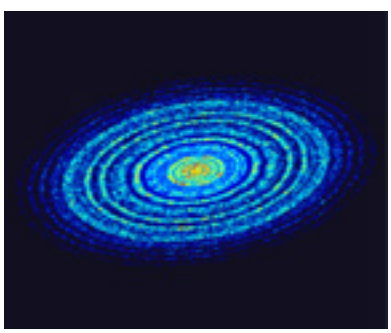
This modelling study is from the Acousto-Optical Tomography project (Biophotonics@ Tyndall) investigating the application of wavefront shaping methods to focus light through tissue-like media. The image shows the simulated wave field associated with an application of wavefront shaping in a random medium. The highly diffusive random slab medium, together with a tailored wavefront, form a focus of the size of a typical wave speckle by overcoming multiple scattering. Time reversal symmetry of the wave equation is used to achieve this phenomenon. This project is funded by SFI.



Perfect Pyramid Micro-LEDs

Zhi Li, Vitaly Zubialevich, III-V Materials and Devices, III Nitride material

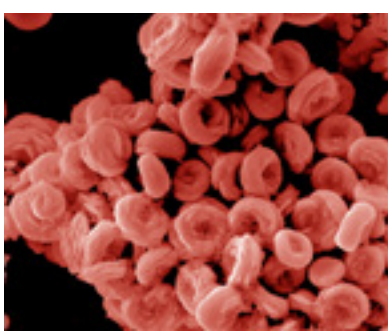
These highly-uniform and crystalline GaN pyramids are obtained by MOCVD in Tyndall using a selective area growth technique. With unique semi-polar facets and geometry, these pyramids are promising to get high efficiency long wavelength emission in the visible range, which provides a pathway to achieve all-GaN-based micro-LEDs displays.



Starry Starry Night

Xing Ouyang , Photonics

This image captures the constellation diagram of received signals with Quadrature Amplitude Modulation (QAM) of an order 256 without being compensated. This type of signal is widely used in our 5G mobile networks, WiFi, etc. for communications, and is obtained as part of the IPIC project. The swirling galaxy visual is because the signal constellations is distorted (rotated) by uncompensated phase noise, and each star in the galaxy represents a QAM signal with an information entropy of 8 bit. What an intriguing starry night in the world of information.

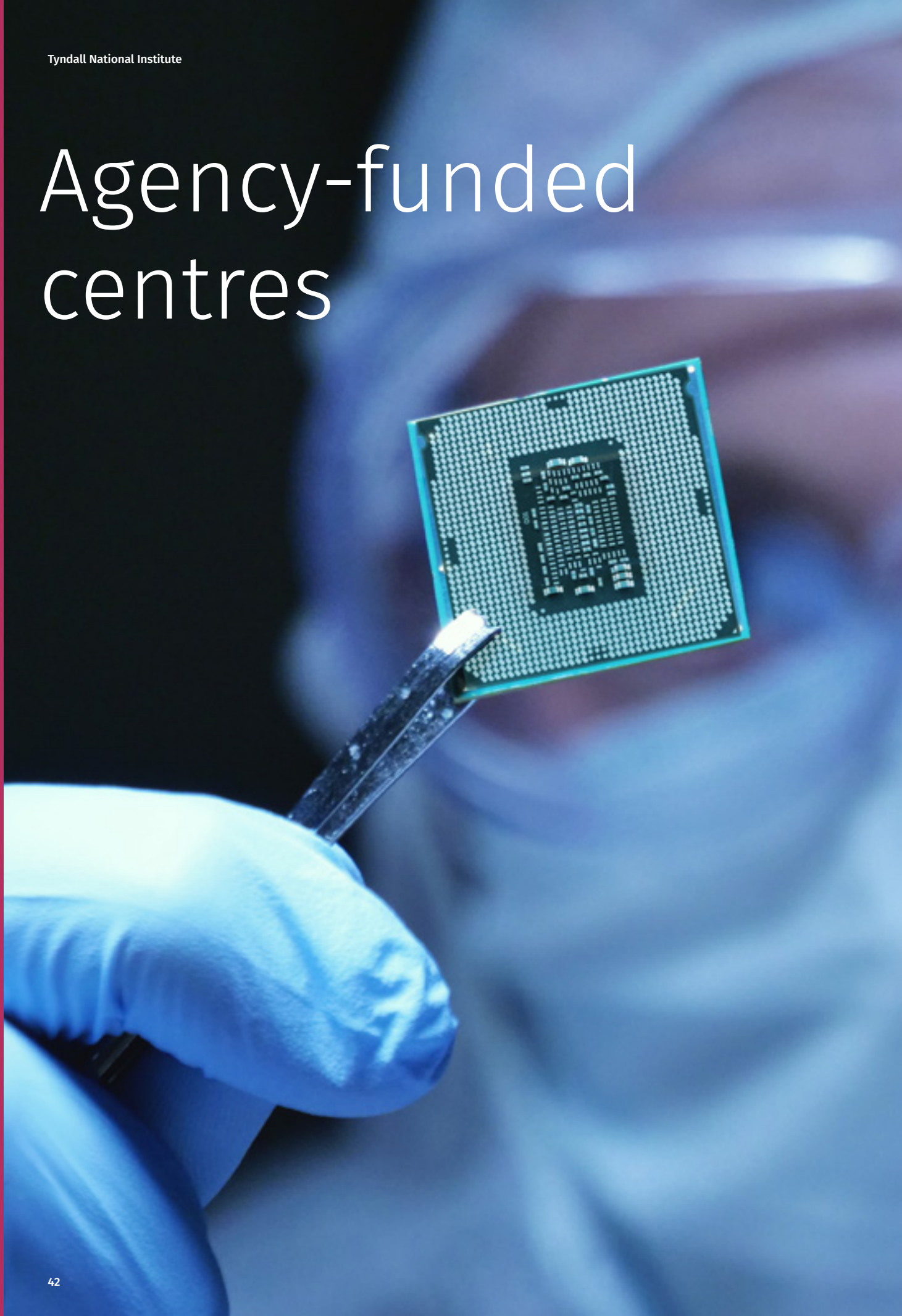


Red Blood Cell Imposters

Fionán Davitt, Materials Chemistry and Analysis

This is a false coloured scanning electron microscope (SEM) image, in which semiconductor SnSe has formed into a shape which resembles that of red blood cells. This image was taken using the FEI Helios SEM in Tyndall.

Agency-funded centres



IPIC
BRINGING PHOTONICS TO LIFE

IPIC is the Science Foundation Ireland centre of excellence for research, innovation and PhD training in photonics. The Centre entered its second funding cycle in 2019 and this has already seen it expand by 30%.

During 2020, IPIC strengthened many of its existing industry research partnerships, such as those with Intel Corporation, X-Celeprint and Rockley Photonics, and developed significant new collaborations with QCoIr Quantum Computing, IBM and others.

IPIC's European position continued to go from strength to strength, with over €4.5m secured in 2020. The year also marked the start of the journey to strengthen IPIC's infrastructure with the backing of significant funding from the Disruptive Technologies Investment Fund (DTIF). This investment will help scale technology from the lab to commercial production.

During 2020, IPIC also launched the Explorer Deep Tech Pre-Accelerator Programme as a partnership between IPIC, Tyndall, Osram and IQE, enabled through industry funding and opens a strategic link to the EU supported IPCEI (Important Projects of Common European Interest) in Microelectronics. This is designed to support the emergence of the next generation of deep-tech based start-ups in Ireland.

Science Foundation Ireland sfi For what's next

Launch of the Explorer Deep Tech Pre-Accelerator Programme

CONNECT
Networks of the Future

CONNECT is the SFI Research Centre for Future Networks and Communications. 2020 was an exciting year for the 10 academic institutions and 44 companies involved in the centre. Tyndall researchers led the 'low energy network' theme, with research focused on sustainable IoT in the areas of battery technology and energy harvesting.

2020 saw the conclusion of industry research projects in the microelectronics, energy for IoT, and biochemical sensor fields, as well as new industry projects commencing, leading to the expansion of the teams undertaking research in these areas.

In Micropower systems, a European patent application for a 'broadband vibrational energy harvesting device combining multiple nonlinearity' was granted in January 2020. An international patent application was also filed for a method of producing laser-induced graphene from sustainable biopolymers.

CONNECT researchers were to the fore in Tyndall Education and Public Engagement (EPE) activities throughout the year. Louise McGrath was named 'Scientist of the week' for the 'I'm a Scientist – Stay at Home' EPE activity during lockdown. Daniela Iacopino won the CONNECT EPE annual award in December 2020, making it three in a row for Tyndall, following Louise McGrath in 2019 and Mariusz Wilkz in 2018.

Science Foundation Ireland sfi For what's next

Louise McGrath named 'Scientist of the week' for the 'I'm a Scientist – Stay at home' – EPE activity during lockdown

Confirm
Smart Manufacturing

Securing Ireland's place at the forefront of advanced manufacturing research globally, with Tyndall as a central member institute, is the overarching objective of Confirm, the SFI research centre in smart manufacturing.

Established in 2017, Confirm opened its new headquarters in Limerick in 2020. The new building includes a testbed to house Ireland's future factory demonstrators, an innovative virtual reality cave, Ireland's first private 5G digital manufacturing network, and a digital manufacturing lab with 3D printing and non-contact 3D part-scanning facilities.

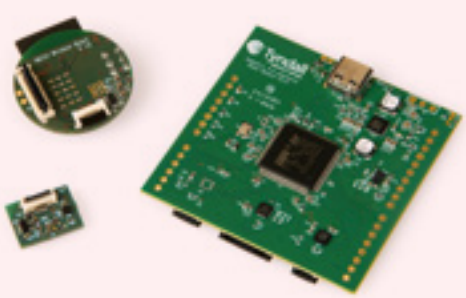
Tyndall's industry co-funded projects make a significant contribution to Confirm's success. The number of these projects increased to six in 2020 with a combined Tyndall budget of over €1m.

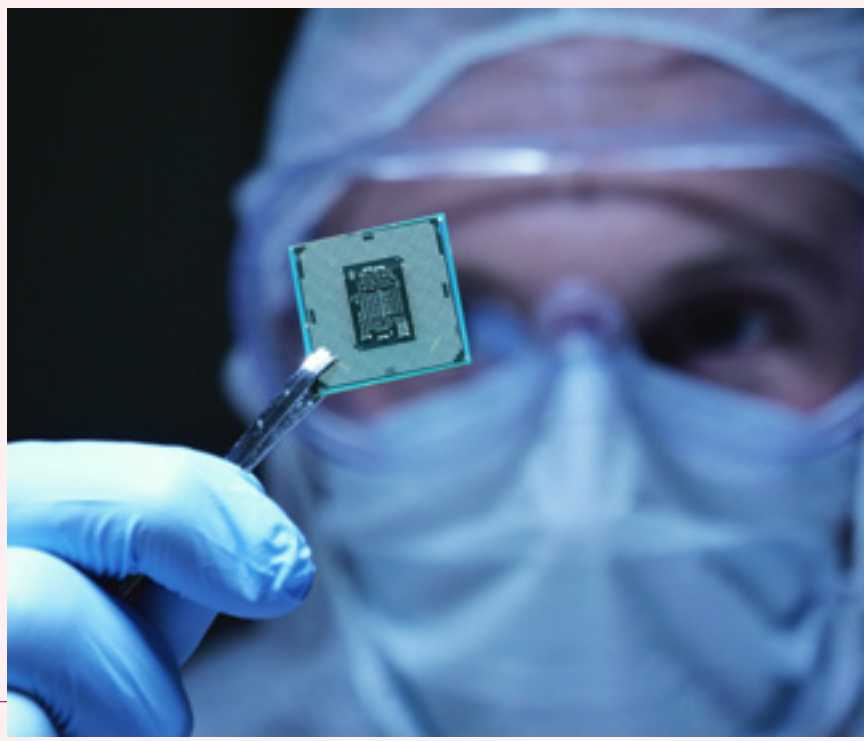
Through Confirm, Tyndall continues to generate economic impact from research having successfully licensed its Condition Based Monitoring (CBS) platform to a global leading multinational pharmaceutical company.

The collaborative project has developed smart sensing technology which will improve manufacturing efficiency on the factory floor and reduce the likelihood of failures in machinery in a variety of high-volume manufacturing and industrial process applications for Industry 4.0.

The technology under development supports continuous and real-time multi sensor data capture, allowing for enhanced prediction of potential failures. This has the potential to translate into quantifiable cost savings from increased yield and reduced manufacturing line downtime.

Science Foundation Ireland sfi For what's next





Developing future smart manufacturing technologies

VistaMilk

Funded by SFI and the Department of Agriculture Food and the Marine, VistaMilk's mission is to be an agent of responsible and sustainable growth for the Irish dairy and agri-tech industries by being a world leader in fundamental and translational research for pasture-based dairying.

Tyndall, tasked with developing smart sensor systems, is one of four research performing organisations in the centre. During 2020, our research focus expanded into the field of sustainable agri-food development.

Major multinational companies and SMEs, who had never previously worked with ICT research providers, are now working directly with us to develop novel systems for on-field and in-line monitoring. In 2020, five separate industry-focused research projects were initiated under VistaMilk, with significant industry funding commitment.

Additionally, 2020 saw the beginning of high-quality peer-reviewed publications from VistaMilk, with a very sharp increase in the key parameters of research excellence. To ensure a continuous pipeline of research outputs, VistaMilk has completed the hiring of highly talented research personnel from PhD to senior postdoctoral fellow level.

VistaMilk's future will see further expansion of both industry-focused strategic projects and academic, cutting edge, deep-tech sensor systems and solutions.

Science Foundation Ireland sfi For what's next

Padraig Hennessy, CEO, TERRA NutriTECH with Dr Alan O'Riordan, Senior Research Fellow, Advanced Nanosensors and Systems, Tyndall, at the launch of their VistaMilk project which will test for micronutrients in cow's milk as an indicator of their health status. This photo was taken before Covid-19 restrictions

IERC
International Energy Research

The International Energy Research Centre (IERC) at Tyndall, delivers multidisciplinary energy systems research ranging across energy saving, production and storage technologies, to policy and regulation and business models.

The Centre's research outputs provide evidence to support national energy policy as well as the work of the International Energy Agency, the ISO, IEEE and relevant European technology and innovation platforms.

In 2020, IERC received €2m from the European Commission to lead a consortium of ten partners from seven EU member countries on the UP-STAIRS project (UP-lifting Communities: Structuring Collective Action for Sustainable Local Transition and Identifying Regulatory Solutions for Adopting Frontier Technologies and Disruptive Business Models).

IERC also became a partner in HP4All, a Horizon 2020 project to remove barriers to the take-up of heat pumps.

During the year, the IERC project 'Fostering Youth Social Inclusion through Blockchain for Sustainability' became the first award under Erasmus+. The completed NOVICE Horizon 2020 project, coordinated by IERC, was lauded by the European Commission as a pioneering project on dual energy services. The StoreNet project, completed in December 2020, was an SEAI 2020 Award finalist in the research and innovation category. In addition, IERC staff authored nine journal publications as well as giving eight conference presentations.

Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

Twenty homes in Dingle, Co. Kerry, tested the potential of a new storage technology for the StoreNet Project

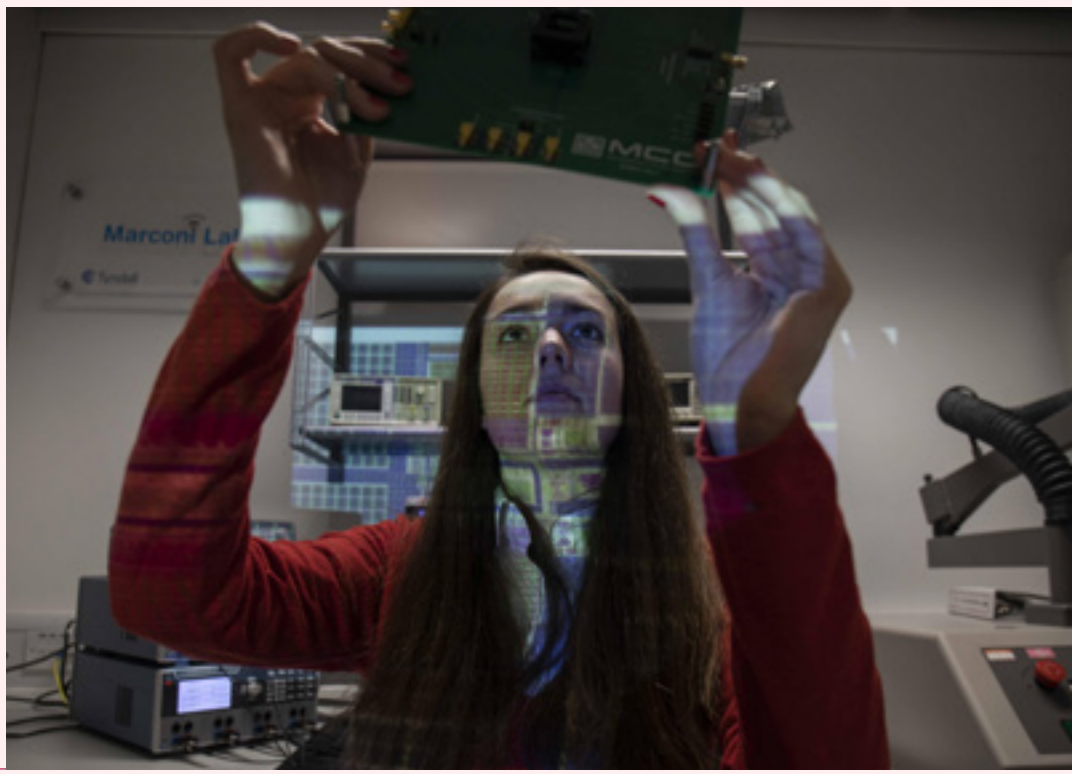
MCCI
Microelectronic Circuits Centre Ireland

The goal of the Microelectronic Circuits Centre Ireland (MCCI) is to be the number one microelectronic circuits research centre globally for industrial and academic collaboration by 2025. MCCI works collaboratively in microelectronics circuit design to improve the performance of mixed-signal circuits required by industry. MCCI's research focus is on mixed-signal, analogue and RF circuits. Projects have algorithm, digital design, IC architecture or system architecture components.

Enterprise Ireland and IDA have approved a further €10m in funding for MCCI for the next five years. The technology centre has also competitively won funding from industry and Europe, under the Horizon 2020 programme, bringing total investment into microelectronic circuit research to €9m per annum. Thirteen of the centre's 21 publications in 2020 were in Tier 1 conferences and journals. In addition, MCCI's 19th IP licence was completed during the year.

The centre is committed to the development of an engineering talent pipeline for the global semiconductor industry with 10 members of staff moving to industry roles in 2020. This highlights the impact the centre has on talent creation for microelectronics.

TECHNOLOGY CENTRE
SUPPORTED BY ENTERPRISE IRELAND



Annamaria Fordymacka MCCI PhD student in Mixed-Signal IC Design in the Marconi Lab

esa space solutions centre Ireland

Established in 2016, the European Space Agency Space Solutions Centre (SSC) Ireland, led by Tyndall, is a consortium of RPO partners with funding support from Enterprise Ireland and the European Space Agency. The SSC Consortium Partners are Tyndall, Athlone Institute of Technology, MaREI/UCC and Maynooth University, and they were joined by University College Dublin in 2020. The centre comprises three core elements:

- ESA BIC Ireland – a geographically dispersed business incubator that supports early-stage ventures with a connection to space.
- ESA Technology Transfer Demonstrator – a funding mechanism to enable the transfer of space technology, thereby leading to the development of new terrestrial applications.
- Technology Broker – a matchmaking service connecting companies in Ireland with others both nationally and across other ESA Member States with technology transfer being the ultimate objective.

By December 2020, there was a total of 22 companies approved for ESA BIC Ireland support. Five companies were approved during 2020 – AutoPlan, Geckos United, GeoAerospace, ProvEye and waytoB. In addition, three companies graduated from ESA BIC Ireland – Alcass Health, DroneSAR and PixQuanta.

A significant development in mid-2020 saw Peter Finnegan appointed manager of the SSC. 2020 also saw the commencement of the SSC Ireland Lunch and Learn webinar series. The series has already helped to generate commercial transactions between a number of participating ESA BIC Ireland companies.

ENTERPRISE IRELAND
where innovation means business

Peter Smyth, Commercial Director at Tyndall; Kevin O'Neill, CEO of PixQuanta; and Peter Finnegan, Manager, ESA Space Solutions Centre Ireland promote some of PixQuanta's medical, VR and automotive applications being commercialised under a new ESA contract

Financial report

Income and expenditure summary

Income	2020 €000s	2019 €000s
Government grant	9,000	7,000
Research	33,036	32,525
Exceptional Infrastructure	967	0
UCC contribution	2,278	2,084
	45,281	**41,609**

Expenditure	2020 €000s	2019 €000s
Remuneration costs	26,660	25,817
Equipment and infrastructure	2,898	3,175
Consumables and related costs	10,025	9,328
Other operating and deferred costs	5,698	3,289
	45,281	**41,609**

Board members

Eoin O'Driscoll
Chairperson

Marcus Breathnach
Department of Enterprise, Trade and Employment

Caroline Dowling
DCC Plc & IMI Plc

Dr Ann Kelleher
Intel Corporation

Prof. Anita Maguire
University College Cork

John Mullins
Amarenco Group

Prof. Bram Nauta
University Of Twente

Sean O'Sullivan
SOSV

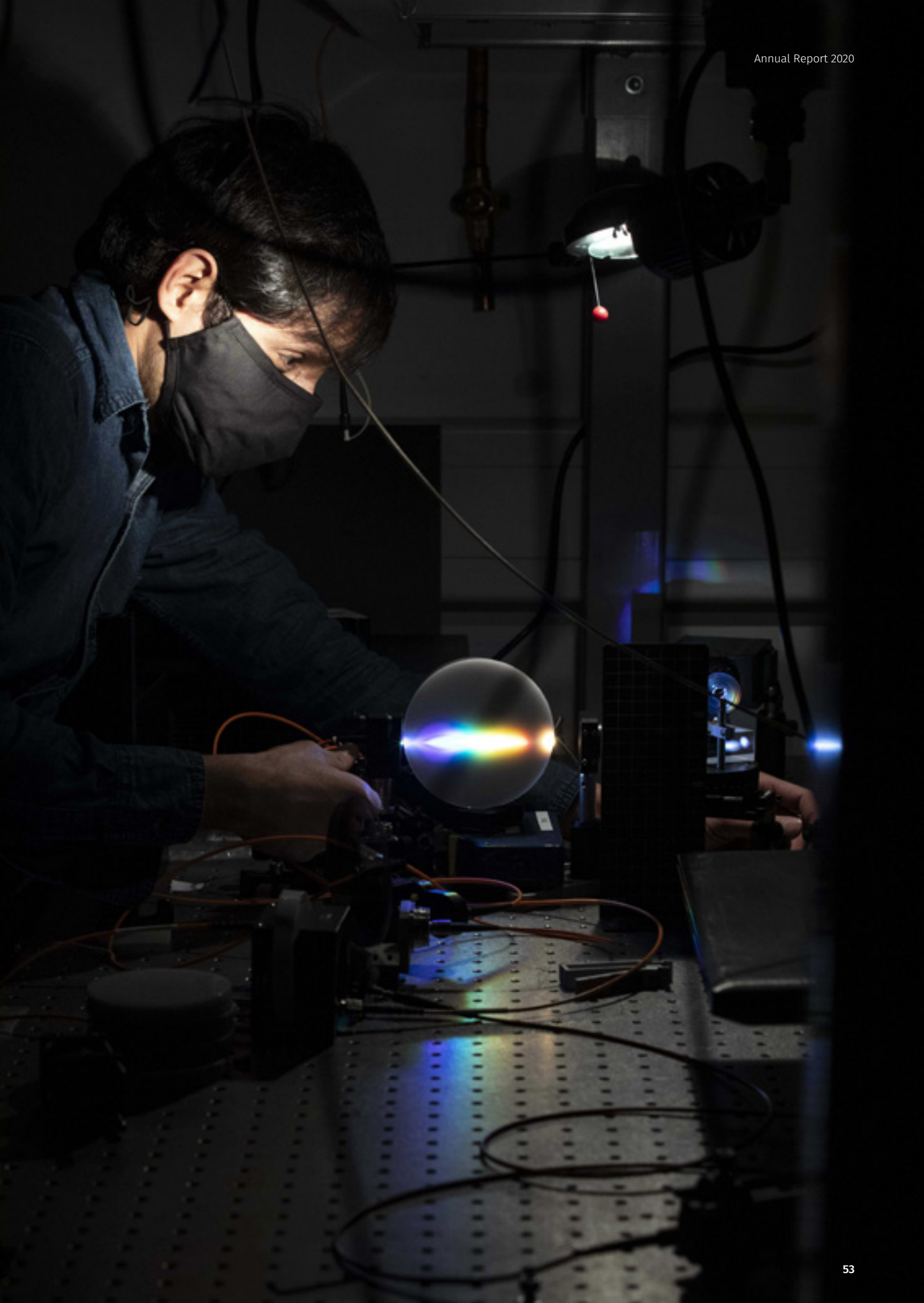
Prof. Richard Penty
University of Cambridge

Patricia Reilly
Department of Agriculture, Food and the Marine

Prof. Steven Ringel
The Ohio State University

Prof. William Scanlon
CEO

Jane Williams
Sia Partners



Rialtas na hÉireann
Government of Ireland

Tionscadal Éireann
Project Ireland 2040

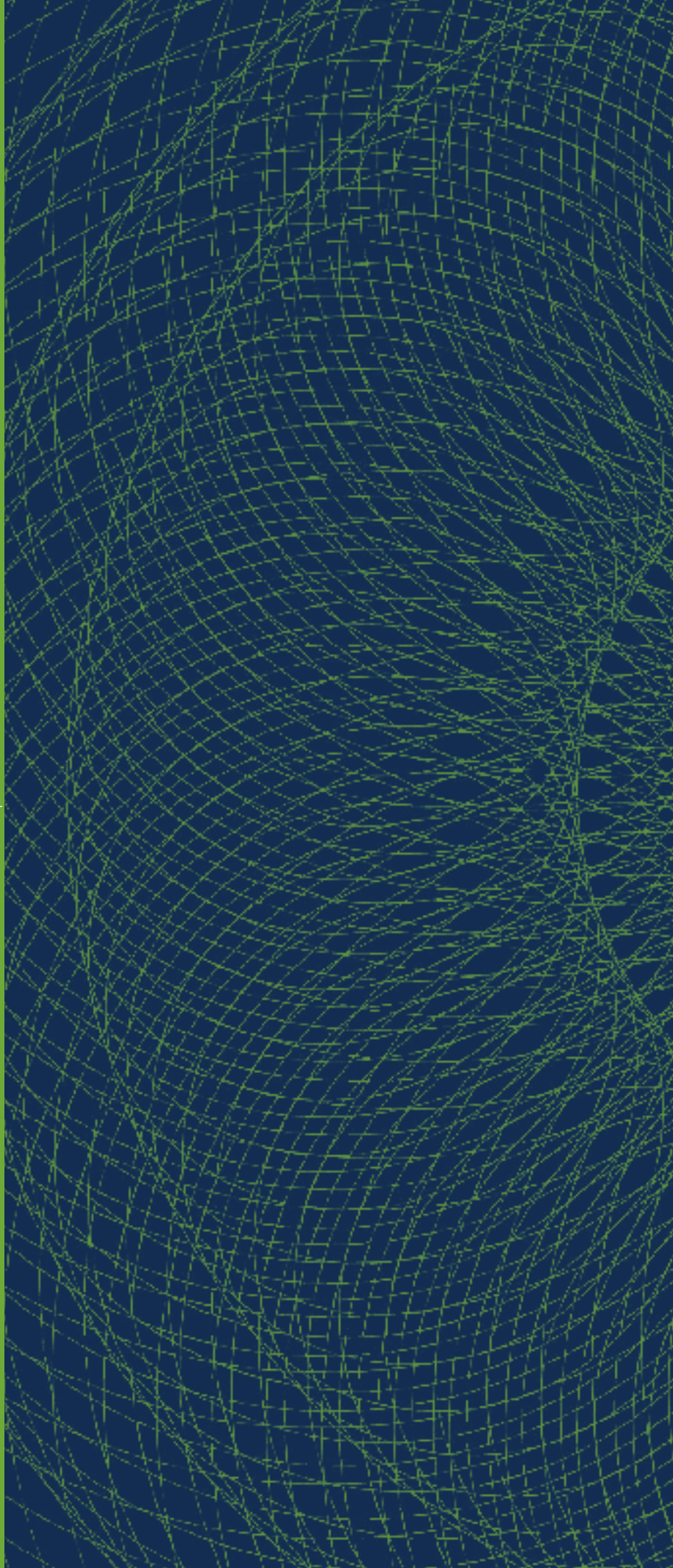
Ireland's European Structural and Investment Funds Programmes 2014-2020
Co-funded by the Irish Government and the European Union

European Union
European Regional Development Fund

Oculus

Daniel Smallwood, Integrated Magnetics Electrochemical Materials and Energy

Image depicts the diffraction pattern from a circular photomaskocculter, with UV light rays propagating according to the Huygens-Fresnel principle



Tyndall National Institute
Lee Maltings
Dyke Parade
Cork, Ireland
T12 R5CP

info@tyndall.ie
www.tyndall.ie