IPIC Information

https://www.ipic.ie/research/

BioPhotonics

The objective of the Biomedical theme is to work towards developing the World's smallest integrated imaging system for guided surgery. In the future, surgeons will require the ability to generate high quality, diagnostic images deep within the body using micro-scale instrumentation such as arterial guidewires. This Theme will develop major novel innovations in micro-scale cameras and surgical platform integration technologies, multi-spectral diagnostic imaging and in-body optical powering and data transmission.

Projects in this theme:		Location
1	Development of Optical Probe for Non-invasive Evaluation of Bone Quality	Tyndall
2	Spectroscopic Assessment of Stored Red Blood Cells	Tyndall
3	Upconversion luminescence DNA-origami nanodevice for pain biomarkers sensing	Tyndall
4	DNA-origami based detection of subtle surface modifications in proteins as a means for neurological disease diagnosis	Tyndall
5	Bone boundary detection using optically enhanced surgical instrumentation	Tyndall
6	Computational models for differentiation of cancer and non-cancer tissues and correlation of their spectral and imaging features	Tyndall
7	Identification and localization of cancer tissues in videos and static reflectance images	Tyndall
8	Low-cost speckle contrast imaging demonstrator for outreach activities	Tyndall
9	Optical wavefront optimisation using non-linear light-emitting targets	Tyndall

Optical Communications

The Communications theme will focus on real-time internet that will require a converged wireless/optical edge cloud with unprecedented ability to dynamically reconfigure in the wavelength and time domain in response to rapid and massive bandwidth fluctuations and latency-critical service demands. Coherent communications systems offer the potential to deliver this vision, but are currently orders of magnitude too expensive. This Theme will address the question: can we build a coherent transceiver at the tens of Euro cost point required for the network edge and, if so, how will this transform metro-scale access network design?

Projects in this theme:		Location
1	Photonic generation of THz signals for future high capacity wireless communication systems	DCU
2	Optical Communications Telemetry Analysis with Python	Tyndall
3	Automation of Spectral Analysis of Lasers through Python	Tyndall
4	High-speed Digital Signal Processing Design for Real-Time FPGA	Tyndall
5	Radio front end and baseband design based on SDR/FPGA platform	Tyndall
6	Machine learning techniques for performance monitoring of high speed 100 Gigabit/s optical communication links'	Tyndall

Monolithic and Heterogeneous Integration (Cork):

The Monolithic and Heterogeneous Integration theme will develop a range of essential semiconductor material, device and integration technologies, with a key objective being to find new ways to combine photonics and electronics together on multiple substrates (silicon, ceramic, polymer etc.) with unprecedented simplicity and cost-effectiveness, using transfer printing. We refer to this colloquially as 'printed photonics on anything'.

Projects in this theme:		Location
1	Design and experimental study of Bloch surface wave sensors and filters.	Tyndall
2	Lasers and photonic devices: characterisation and design (lab based)	Tyndall
3	Lasers and photonic devices: simulation and design based on C++	Tyndall
4	Automation of photonic testing using Arduinos (home/lab based)	Tyndall

Packaging and Hybrid Integration (Cork):

The Packaging and Hybrid Integration theme will focus on the high cost of photonic packaging, which can amount to as much as 80% of total product cost in some applications, which has restricted the deployment of photonics to a relatively small number of mass and niche markets to date (albeit markets of enormous value). This Theme will develop optical and electrical wafer-scale assembly and packaging processes and low cost cooling technologies that aim to 'break this cost barrier'.

Projects in this theme:		Location
1	Photonic packaging for quantum cryogenic applications	Tyndall
2	Laser integration with photonic integrated circuits	Tyndall
3	Modelling of the heat sink integrated micro-thermoelectric cooler for thermal management of the photonic device	Tyndall

Tyndall (Micro & Nano Systems) Information

https://www.tyndall.ie/micro-nano-systems

Emerging Materials & Devices (Cork)

New materials and new devices are at the core of Tyndall research. Advances in technology depend on integrating new materials often in novel ways, to improve the electronic, optical, magnetic, thermal or chemical performance of devices. Our 'CMOS++' team focus in particular on meeting the demand for faster electronic devices, on a smaller footprint, that at the same time consume less power, using 'beyond CMOS' and quantum technology.

Projects in this theme:		Location
1	Machine Learning in Materials Discovery and Analysis	Tyndall
2	Making Memories: Ultra-thin Multiferroics for Disruptive Data Storage Technologies	Tyndall

Integrated Sensors (Cork)

Our 'Sustainable Agri, Food, Environment (SAFE)' team develop applications based on novel bio/chemical sensors and systems to provide real-time informed decision-making capacity to users in animal & plant health; soil; water, air quality. Systems Integration.

Projects in this theme:		Location
1	Electrochemistry approaches for optimisation of the performance microneedle based sensors	Tyndall
2	Development of Sensor to detect Bisphenol A (endocrine disruptors) in river water	Tyndall
3	Real-time Electrochemical Sensor for Phosphate Sensing in Soil Water	Tyndall

Micro-Power Platforms (Cork)

This includes our 'Energy for IoT' group who work on simulation, design, fabrication and packaging for Power-Management Integrated Circuits (PMICs), energy generation, harvesting and energy storage. This technology has the potential to replace batteries in the future.

Projects in this theme:		Location
1	Spin Hall Nano Oscillator (SHNO) arrays for tuneable microwave signal generation	Tyndall
2	Sustainable battery electrode materials and electrolytes to power smart sensors in the Internet of Things	Tyndall

Smart Systems (Cork)

Smart Systems are self-sufficient intelligent technical systems or subsystems with advanced functionality, enabled by underlying micro- nano- and bio-systems and other components.

Our Bioelectronics team work on the development and application of devices and systems that interface directly with bio-fluids in scenarios related to human health.

Our Human-Centric systems team work on smart, connected "things", IoT applications and autonomous devices. Next generation sustainable devices improving human:environment interactivity & wellbeing:

- Capturing & analysing humans physiological: environmental interactivities (work, home, play).
- Reporting & predicting wellbeing impacts (singular & combined) of those interactivities.

Projects in this theme:		**Location**
1	Virtual Reality can be real: real-world object tracking for VR	Tyndall
2	Wearable Systems and Data Analytics for the treatment of Bruxism	Tyndall
3	Marine Data Analytics- Machine learning Algorithms to optimise Seaweed growth	Tyndall

Wireless RF communications (Cork and Dublin)

We have expanding teams working in our Cork and Dublin offices in this exciting area covering technologies like RF Passive Components, Reconfigurable Devices, Adaptive RF Circuits, Microwave/ Millimetre-wave RF Systems, RF Front-ends and RF-MEMS.

Projects in this theme:		**Location**
1	Electro-optical characterization of screen-printed transparent film as a cost-efficient, scalable, and effective approach for manufacturing of transparent and flexible wearable antenna	Tyndall

MCCI Information

https://www.mcci.ie/

MCCI is a microelectronic research technology centre. We provide a state of the art design infrastructure to tackle difficult technology challenges driven by global electronic application needs. In close collaboration with Industry, we help develop technologies that will enhance people's lives and the world we live in. Our research has positive impacts on healthcare, communications, Industry 4.0, Energy reduction and production, sustainability and automotive applications.

MCCI is focused on ground breaking microelectronics research. We have enabled a strong collaboration and specialist ecosystem that allows a team of world-class researchers and postgraduate students to work on application driven research. Microelectronics circuits are a key enabling technology, which are fundamental to all electronic systems, and this research is central to the advancement of the ICT sector and its future growth. The centre's research roadmap is centred around the delivery of research for a broader range of applications from Future Network 6G/7G Communications, connected smart devices or Internet of Things (IOT), Medical Device Technologies(wearables or implantables) , Smart Industry & Agri and Quantum computing.

Projects in this centre:		**Location**
1	Sensor interface circuits	Tyndall
2	Circuits for Quantum Computing	Tyndall
3	Circuits for Smart Medical Instruments	Tyndall

IERC Information

http://www.ierc.ie/

The International Energy Research Centre at Tyndall National Institute is Ireland's leading not-for-profit professional energy research centre. Our work is independent and is free of any expressed technological bias, ideology or political position. By becoming a partner of the IERC you will be supporting independent energy research affecting Ireland, both nationally and internationally.

The centre is supported by a variety of funding sources including Ireland's Department of the Environment, Climate and Communications, the EU's H2020 research programme, Science Foundation Ireland, the Sustainable Energy Authority of Ireland (SEAI) and industry collaborators. Our current research portfolio features projects in the following areas:

- Community energy and microgrids
- Embedded and micro-generation and energy storage
- Electrical power systems and Distributed Energy Resources (DERs)
- Solar energy
- Data analytics, digitalisation and ICT integration within the energy sector
- Achieving living environments through innovation that take into account occupant comfort
- Decarbonisation of heat and transport
- Sustainable heating and cooling energy, ventilation, daylighting and electricity in buildings and the built environment
- Decarbonisation of SMEs and the industrial sector
- Innovative business models as well as regulatory and policy options for the low carbon energy economy
- Energy policy innovation

Projects in this centre:		Location
1	Impact of distributed energy resources (DERs) in the low voltage distribution network	Tyndall
2	Hardware-in-the-loop (HIL) validation of control systems for grid-connected DERs (Power Electronics and Control Engineering)	Tyndall
3	ICT requirements in a community-based microgrid	Tyndall
4	Cyber security in smart community-based microgrid operation	Tyndall
5	Flexible Energy Market for Residential Consumers	Tyndall
6	Modelling retrofitted near zero energy buildings	Tyndall
7	Modelling thermochemical heat storage devices for residential applications	Tyndall
8	Investigation of new business models to address the split incentive problem	Tyndall
9	High definition modelling of multi-vector energy system using hardwardware-in-the-loop (HIL) techniques	Tyndall