Interreg North-West Europe
OIP4NWE
European Regional Development Fund

OIP4NWE
Open Innovation PIC Pilot

Enhanced and scalable photonic integration technology.

OIP4NWE

Open Innovation PIC Pilot

Open-Innovation Photonics pilot line for North West Europe

The Interreg NWE project OIP4NWE aimed at establishing an open innovation pilot line for the development of generic photonic integration technology. Integrated photonics is the emerging technology where the manipulation of light takes place on a chip, which could make some components an order of magnitude cheaper, smaller and more energy-efficient compared to today's solutions. By providing technology support to SMEs across Europe, the project contributed to strengthen the competitiveness and innovativeness of European SME sustainably on the global markets. The pilot line will be established in four phases:

Set-up

Creation an open-access pilot line for generic PICs through open innovation. The pilot line comprises 3 consecutive manufacturing stages for creating the raw PICs (part of the equipment was installed at TUE, NL; manufacturing is done by SMART, NL), integration of optics (VUB, BE) and integral packaging (TNI, IE).

Validation

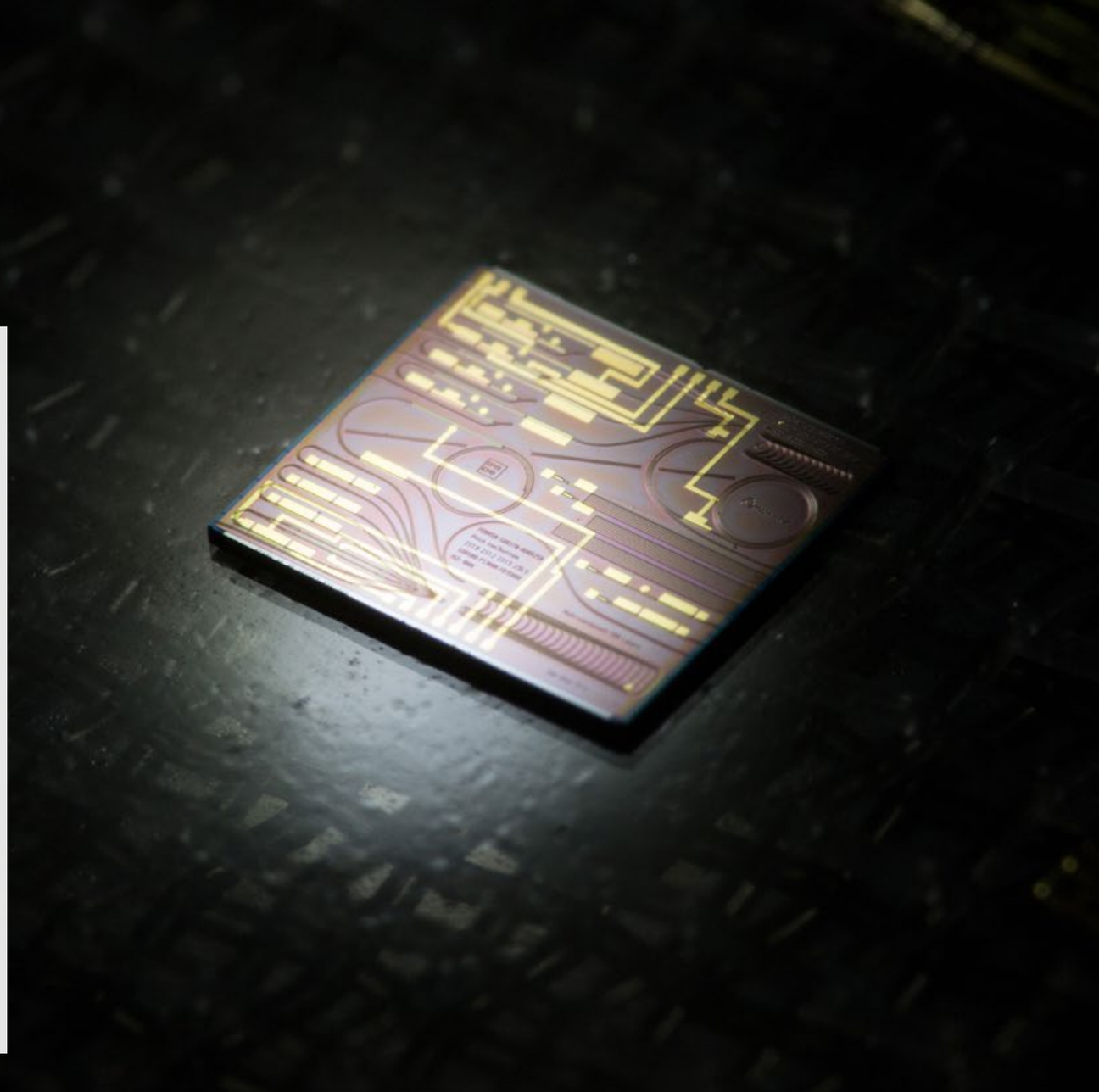
The pilot line is being evaluated and validated by the participating SMEs Technobis Fibre Technologies, mBryonics Limited and VTEC Lasers & Sensors.

Voucher

As first stimulation of uptake in SMEs, a voucher scheme for external SMEs was set up, to provide technology support which contributes to increasing the maturity of their product. The success stories of these SMEs will be shared to show what is possible within the open innovation model.

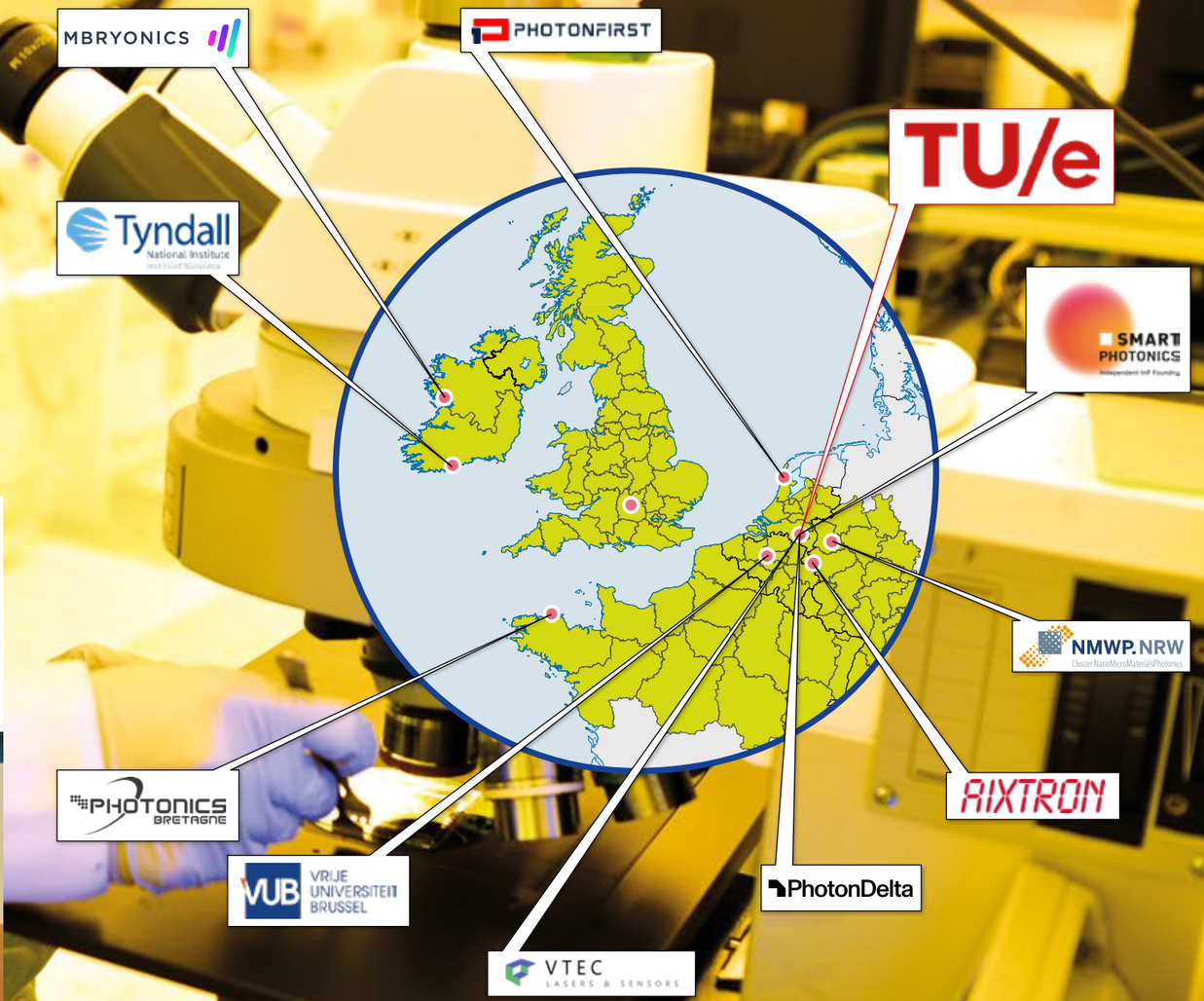
Long-term

A TransNational Network was developed including business clusters to reach out to SMEs in all relevant sectors. Network efforts are driven by partner TNI (PIX-APP), TUE (JePPIX Pilot Line), VUB (ACTPHAST), Photonics Bretagne, Photon Delta and Cluster NMWP.NRW.



The OIP4NWE consortium

OIP4NWE unites seven enterprises, three research institutes and four innovation clusters. It includes innovation leaders (Netherlands, Belgium, Germany), strong innovators (Ireland, United Kingdom) and a high-potential region in France.

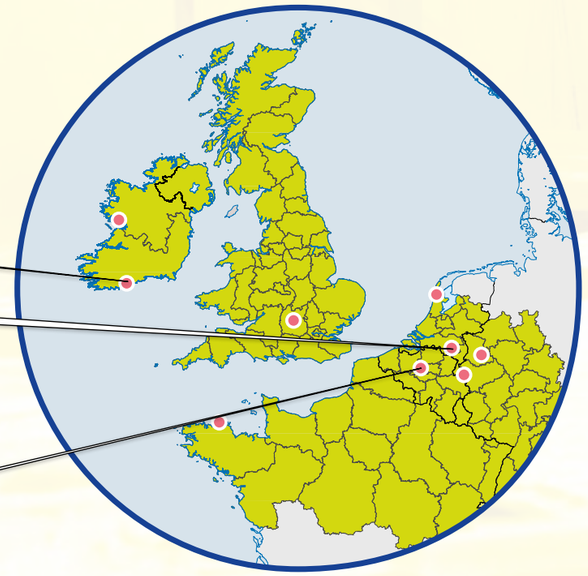


Lead Partner

Project Partners

OIP4NWE – the Open Innovation PIC pilot line!

Developing new process steps for photonic integrated circuits (PICs) based on 4” indium phosphide wafers and operating an infrastructure for pilot production of PICs, including packaging and external optics.



Tyndall National Institute

SMART PHOTONICS Independent InP Foundry

VUB VRIJE UNIVERSITEIT BRUSSEL

Open innovation for more reliable PIC manufacturing Pilot Line part 1 – front-end.

The front-end of the pilot line capabilities will be implemented at the premises of the Eindhoven University of Technology and will be complemented and operated by SMART Photonics during the project execution. The infrastructure investments will be instrumental for the transition to a manufacturing with higher yield and lower costs, enabled by more accurate processing of larger Indium Phosphide substrates (4 inch) with a high degree of automation in wafers handling.

The industrial research phase consisted of equipment and process development for epitaxy, deposition of dielectrics and semiconductor etching, which are key processes in the manufacturing of PICs. The epitaxy and PECVD equipment allow for highly uniform growth of semiconductors and deposition of dielectric layers, respectively, also, etching processes with high throughout and etch depth accuracy of waveguide structures become reasible. Such state-of-the-art equipment and processes will be used to improve the maturity of PICs manufacturing.

Author: Victor Dolores Calzadilla
– Eindhoven University of Technology.

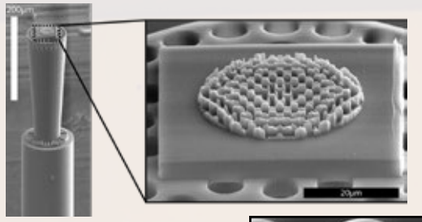
***MOCVD** (**M**etal **O**rganic **C**hemical **V**apor **D**eposition) deposition system for the deposition of semiconductor layer structures on 4 inch wafers.*

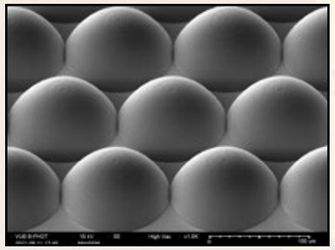
The AIXTRON epitaxy reactor is part of the front end of the pilot line for PIC production. The system features automatic cassette-to-cassette loading to reduce particle contamination.

Optical interfacing of PICs with the outside world
Pilot Line part 2 – back-end: optics.

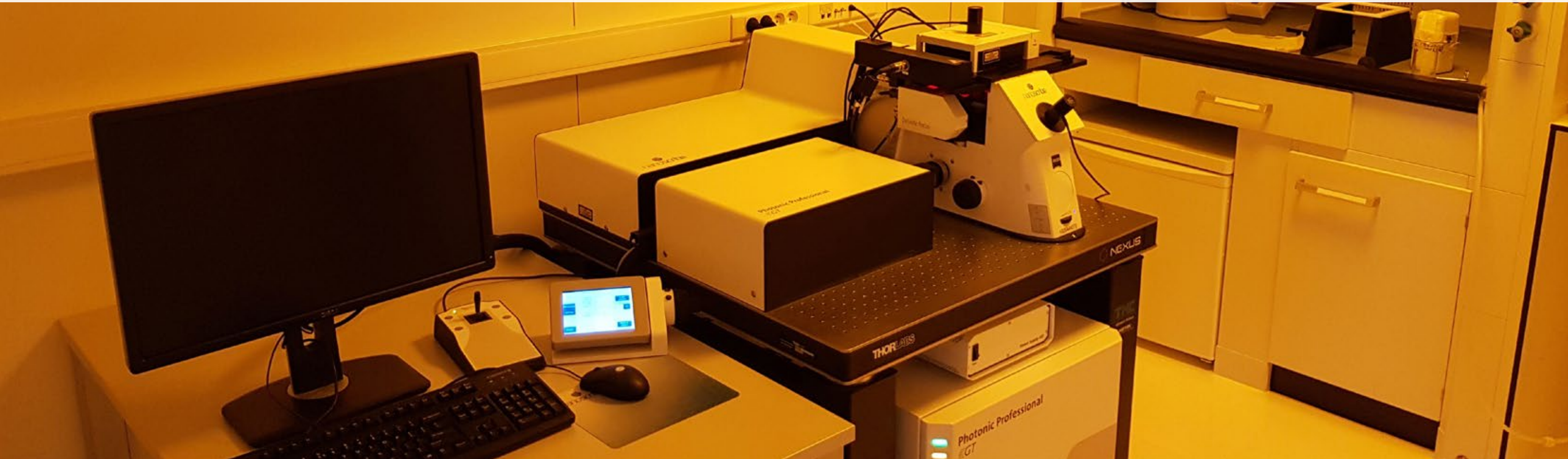
The first part of the back-end of the pilot line capabilities, involving the optical interfacing of PICs, has been implemented at the premises of the Photonics Campus Gooik of the Vrije Universiteit Brussel. The infrastructure and equipment investments are instrumental for the manufacturing of high-quality micro-optical and micro-mechanical components with sub-micrometer precision with short fabrication times.

In the project, we have performed the process development for the fabrication and integration of micro-optics, interposer waveguides and mode conversion coupling structures that are key in the high-efficiency interfacing of PICs with the outside world. Laser-based micro-machining allows the fabrication of refractive and diffractive optical components, interfacing structures and of mechanical alignment features to achieve high-precision alignment and high-efficiency coupling to the PIC. In addition, it allows the creation of optofluidic devices where an interface between the PIC and microfluidic channels is foreseen to achieve high-performance labs-on-chips. For the up-scaling and volume manufacturing of those micro-optical structures, optical mould making and micro-injection moulding replication processes have been developed and are now available through the OIP4NWE pilot line.





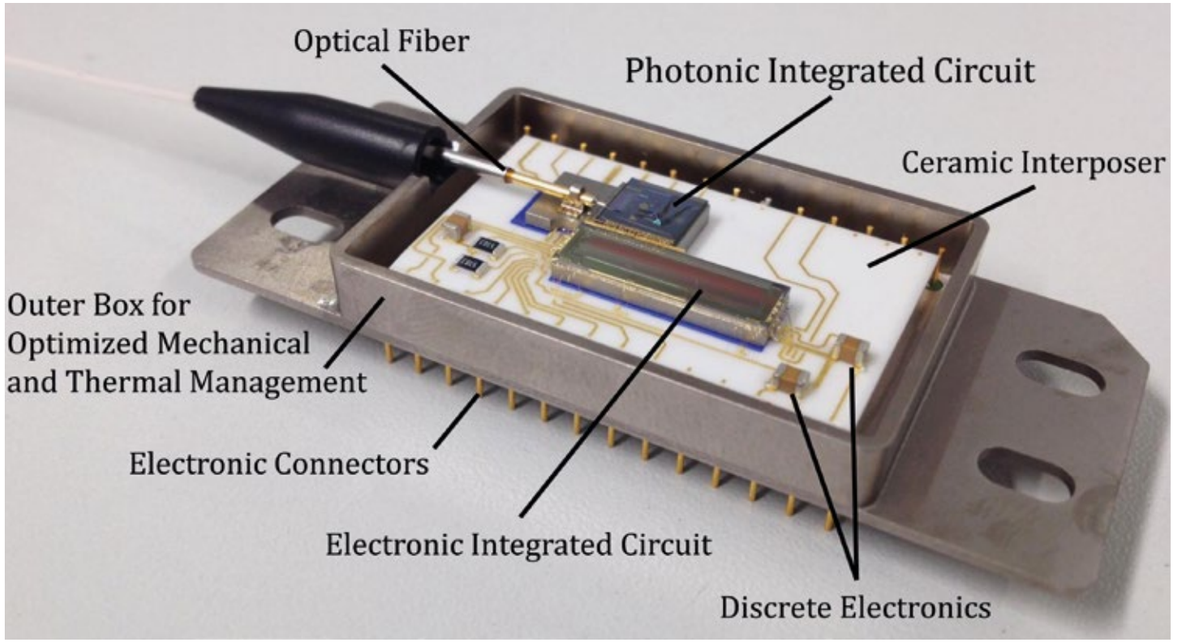
Author: *Jürgen Van Erps*
– Vrije Universiteit Brussel.



Integrated Photonics Packaging
Pilot Line part 3 – back-end: packaging.

The second part of the back-end of the pilot line capabilities was implemented at the premises of the Tyndall National Institute in Cork, Ireland is operated by Photonics Packaging Group. The infrastructure investments are instrumental for the optimisation of the ultra-precision connectors required for PIC packaging. The industrial research phase consisted of the equipment and process development for a fully PIC packaged solution, therefore interfacing the PIC to the environment via an assembly of optimized connections with glass-fibres and electronics. The assembly of multi-level electrical interposers in glass/ceramic will be designed for high-frequency applications and high density PIC connections. The aim was to increase the electrical alignment control thus reducing the rejection rate in conjunction with an improvement of the fiber alignment procedure to guarantee a high standard connection characterized by low loss optical coupling together with a fundamental advance in the thermal management of the packages. This is crucial as high-frequency devices generate large amounts of heat that could negatively affect the PIC performance and ultimately irremediably damage parts of the circuit.

Author: *Marc Rensing*
– Tyndall National Institute - UCC.



References

First companies have benefited from the pilot line. Individual examples are explained on the following pages.

MBRYONICS

omnisens
Securing asset integrity

AMAZEC
PHOTONICS

Pilot
PHOTONICS

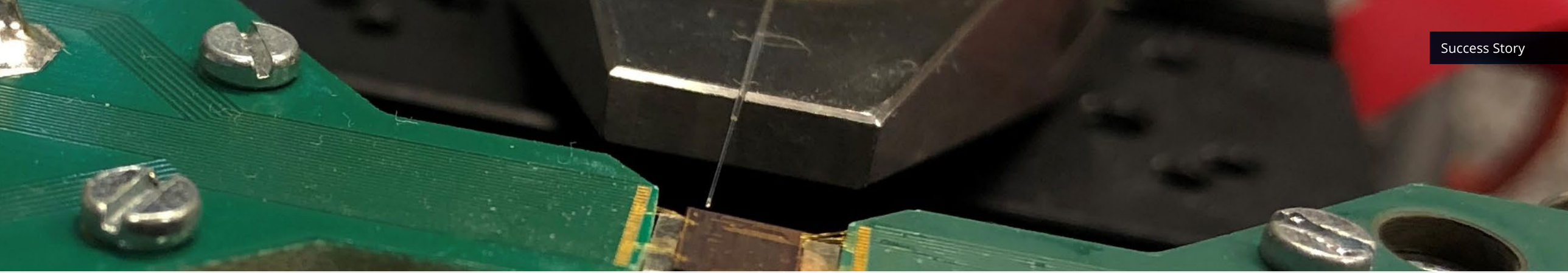
MMATIDIA
A NEW LOOK AT LIDAR

QUSIDE

PHOTONFIRST

VTEC
LASERS & SENSORS

BRIGHT
Integrated
PHOTONICS



Omnisens SA – PICs for monitoring energy industry assets

Using fiber optic-based sensing Omnisens offers continuous, reliable monitoring for energy industry assets. A range of solutions is available for early detection and location of events which may threaten the integrity of the asset. These techniques provide condition monitoring, asset optimization and intrusion detection, based on small changes in temperature, strain and vibration. Monitoring techniques include Brillouin-based Distributed Temperature and Strain Sensing (DTSS), which Omnisens pioneered, Raman Distributed Temperature Sensing(DTS) and Distributed Acoustic (DAS).

Based in Switzerland Omnisens operates throughout the world, either directly or through specialized solution providers, via dedicated application, commissioning and customer service teams. A leader in long-distance fiber optic sensing, Omnisens has pioneered effective real-time asset integrity monitoring solutions for critical oil and gas, power and civil engineering infrastructures.

Our cooperation with the OIP4NWE Pilot Line

Thanks to the OIP4NWE voucher scheme with the associated PIC design and manufacturing capabilities, Omnisens together with its partner at the Swiss Federal Institute of Technology (EPFL) can explore this new world of miniaturization and its suitability for sensing in industrial environment.

omnisens
Securing asset integrity

Omnisens SA
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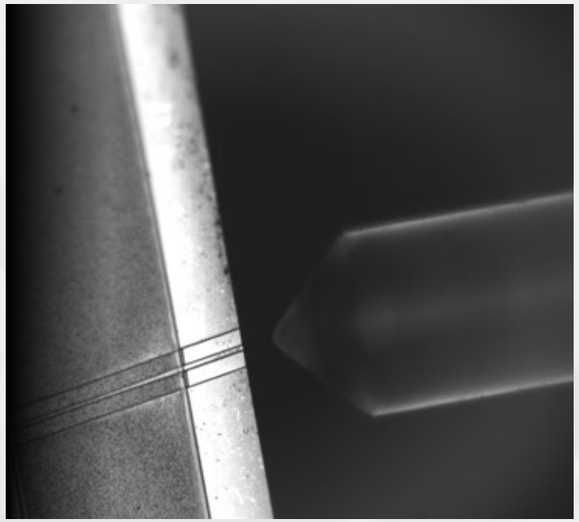

Quside – Quantum random number generation powered by photonic integrated circuits

Quside is a quantum technology company delivering the most advanced randomness solutions for the cybersecurity and high-performance computing markets. A spin-off from ICFO, a world-leading research centre in photonics and quantum science, Quside specializes in the generation, monitoring and processing of randomness. The company has launched several innovative products, including the QN 100, the fastest semiconductor quantum entropy chip, or the RPU, the world's first randomness processing unit. As an active member of the European quantum ecosystem, Quside participates in various initiatives, such as the Quantum Industry Consortium (QuIC), quantum flagship, digital Europe program, and several national efforts.

Our cooperation with the OIP4NWE Pilot Line

Within the framework of the OIP4NWE Pilot line Quside had the opportunity to develop a fully integrated quantum entropy source (QES) in conjunction with several European Partners (Smart Photonics, Tyndall National Institute). The QES, based on phase diffusion in a two laser heterodyne scheme, has been fabricated by Smart Photonics on an InP photonic integrated circuit, and will be able to deliver more than 100 Mbps quantum random numbers. Moreover, a fully packaged solution, based on a small footprint QFN package (<8x8 mm2), developed by Tyndall and containing only electrical connections, will allow for easy integration and testing of the QES. This development will be a crucial step for Quside towards scaling up our QES technology into mass production.

Picture: Fully packaged quantum entropy source in a small footprint QFN package. The QES can deliver more than 100 Mbps quantum random numbers.

Quside

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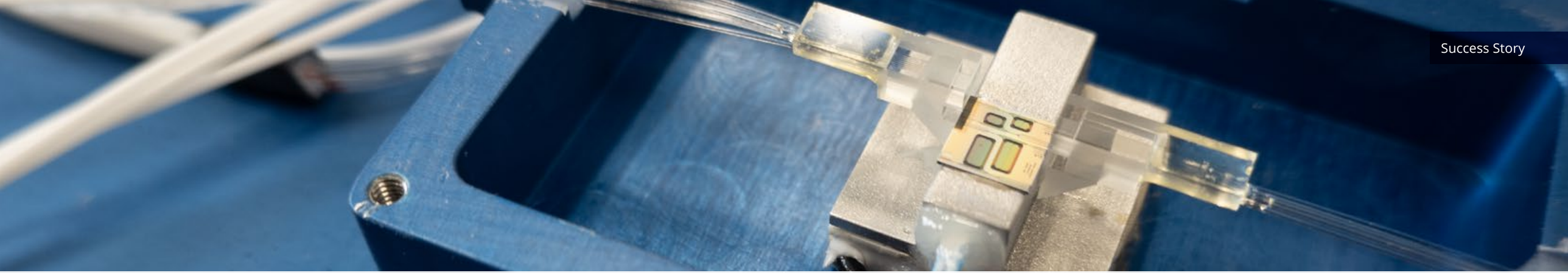
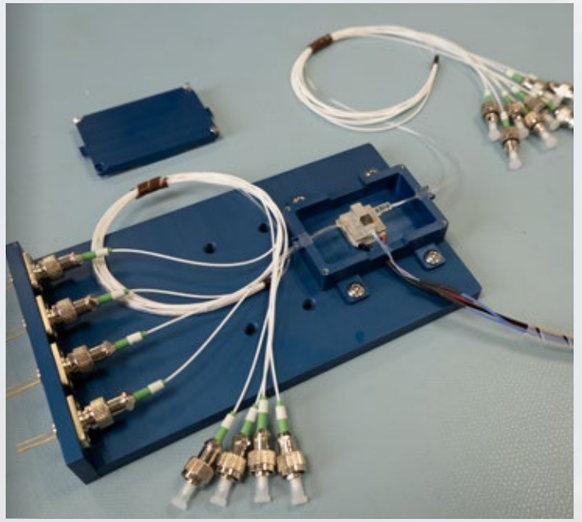


Amazec Photonics – a PIC module for new healthcare applications

Amazec Photonics was founded in 2021 by two medical specialists and two pioneers in integrated photonics. The company aims for a high-resolution system to measure and quantify cardiac functions in human bodies. The existing systems all have a limited resolution, and the best results are reached using an invasive sensor probe close to the heart. Based on earlier R&D demonstrator projects at Technobis Fibre Technologies (now PhotonFirst) where extreme resolutions of wavelength measurement (sub 100 attometer) and thermal sensing was proven Amazec Photonics started the R&D for a dedicated high-resolution system to measure blood temperature fluctuations (thermo-dilution) in the order of 0,00010C. The resolution of the thermal sensor system makes it possible to measure these thermal fluctuations on the surface of the body (pulse, nose, neck arteries), so completely non-invasive.

Our cooperation with the OIP4NWE Pilot Line

The used technology in the sensor system is based on earlier R&D executed in the timeframe 2010 – 2011 for ASML measuring wavelength shift in FBG sensors with a resolution of 100 attometer. In the 10 years between the two projects the PIC technology has matured, new functions, building blocks, architectures and chip packaging strategies became possible. With these new insights we knew a better design for the wavelength meter module is now possible. Using the 2011 PIC module is a possibility, but it requires complex and expensive peripheral equipment. OIP4NWE gave us the possibility to do a trial version of an improved chip in an improved package.



Amazec Photonics BV
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PhotonFirst – Fiber Optics, Forward Thinking

PhotonFirst, previously known as Technobis tft-fos, stands as a frontrunner in the field of photonics, particularly known for its expertise in Photonic Integrated Circuits (PICs). With a rich history of serving high demanding markets, the company has developed a niche for itself in sectors ranging from aeronautics and space to medical technology and automotive testing. At the core of PhotonFirst's philosophy is a commitment to pushing technological boundaries, ensuring its solutions meet the ever-evolving demands of precision, efficiency, and reliability in complex industry environments. This dedication is further evidenced by its significant role in collaborative initiatives like the OIP4NWE, where it continues to influence advancements and applications in the wider photonics ecosystem.

Our cooperation with the OIP4NWE Pilot Line

PhotonFirst's collaboration with the OIP4NWE Pilot Line demonstrates its pioneering spirit in driving photonic innovation forward on PIC packaging process improvements for scaling and industrialisation. Our position in the value chain allows us to provide the application feedback to streamline PIC-based product design for manufacturability, particularly in developing advanced detector and light source chips. By establishing a robust pilot line in partnership with a consortium, PhotonFirst not only accelerates real-world applications in sectors like aeronautics, medical technology, and automotive testing but also strengthens its position as a leading force in ASPICs-based solutions. Within the OIP4NWE framework, PhotonFirst's introduction of a next-gen fiber optic interrogator marks a significant advancement, emphasizing its commitment to enhancing industry applications and setting Europe's position in the competitive global photonics arena.

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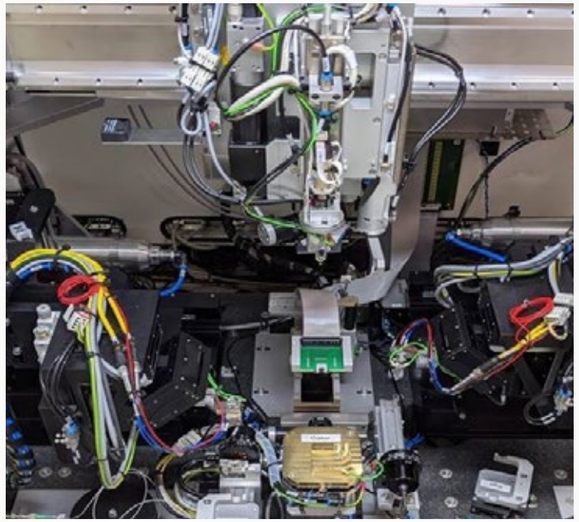

VTEC Lasers & Sensors – EML for datacom

VTEC Lasers & Sensors develops custom solutions for new application areas in photonics and IoT. We provide technology and products for creating, transporting, bundling and analyzing data. Rather than settling only for a one-size-fits-all list of standard products, we also develop customized solutions by listening to the needs of the customer, rapidly test and prototyping to develop new technologies. All capabilities are covered in house – from design to manufacturing of devices, modules to cloud based platforms for analysis and presentation of the gathered intelligence. VTEC has expertise in the design, creation, and testing of photonic applications.

Our cooperation with the OIP4NWE Pilot Line

Within the framework of the OIP4NWE Pilot line VTEC had the opportunity to work with some of the leading companies, knowledge institutes and regional development companies to understand technologies and cooperation and learn about the networking opportunities in the Photonic Ecosystem. Next to that being part of the development and installation of first of a kind epitaxial processing equipment for Indium Phosphide gives great prospects for a high quality and reliable InP production line. As a validation partner, we have the opportunity to explore the technologies for chip and packaging and this resulted in a detailed design of an External Modulated Laser and estimation of the allowed process tolerances.

As a validation partner, we have the opportunity to explore the technologies for chip and packaging and this resulted in a detailed design of an External Modulated Laser and estimati0on of the allowed process tolerances.Some designs have been produced on a 3” wafer process, The new OIP4NWE 4” line is being qualified and we look forward to receiving the chips from this production line.

VTEC LASERS & SENSORS

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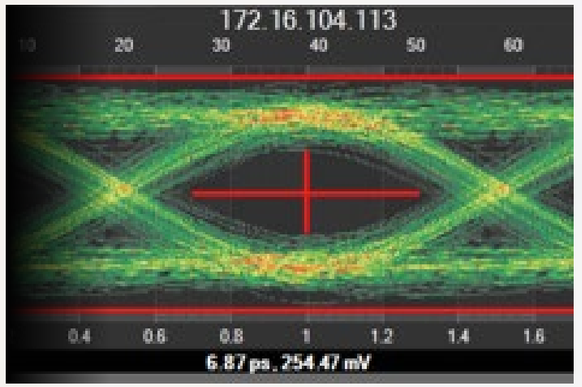

MBRYONICS Ltd. – Bringing Innovation to Light

MBRYONICS Ltd, a privately owned SME located in Galway City, Ireland, is dedicated to serving high-technology industries through its five primary business units:

1. Satellite Free Space Optical Communications
2. Design and manufacture of high-precision optical and mechanical equipment
3. Satellite Operations and Ground Segments System developments
4. Photonic Integrated Circuits (PIC): design, engineering, and AIT of packaged PIC-based components and modules
5. Automation of production, assembly, inspection, and testing for photonics and optics

With over 9 years of experience in satellite systems engineering, Adaptive Optics systems, optical ground stations, silicon photonics transceivers, and satellite optical terminals, MBRYONICS has contributed to various applications, including data relay, telecommunication satellites, quantum networks, Earth Observation, and IoT.

As a validation partner in the OIP4NWE pilot line, MBRYONICS has achieved significant milestones. We successfully developed an Indium Phosphide PIC-based narrow linewidth fast tunable laser, a crucial component for various optical communication projects at MBRYONICS. This laser plays a key role in the development of a coherent modem for inter-satellite optical communications. Our in-house design, in collaboration with SMART Photonics for fabrication, has yielded promising results. We have completed the packaging and testing of the initial PIC run and a new PIC fabrication run is currently in progress utilising the new tools developed through OIP4NWE

In addition to laser development, OIP4NWE has enabled MBRYONICS to develop efficient optical packaging processes. In collaboration with VUB B-PHOT, we have pioneered a novel micro-lens array for advanced PIC packaging, with strong support from the project.

MBRYONICS

MBRYONICS Ltd.
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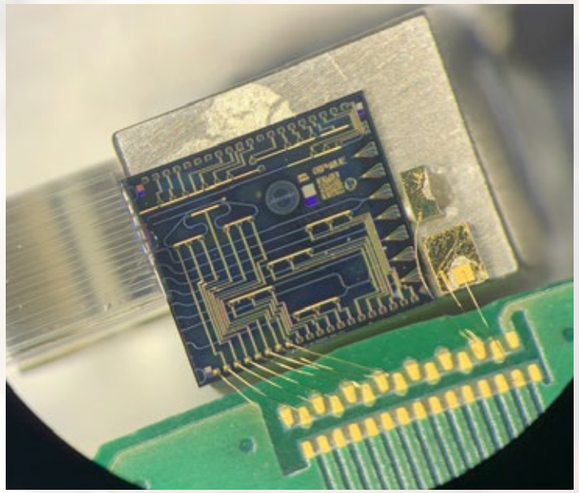
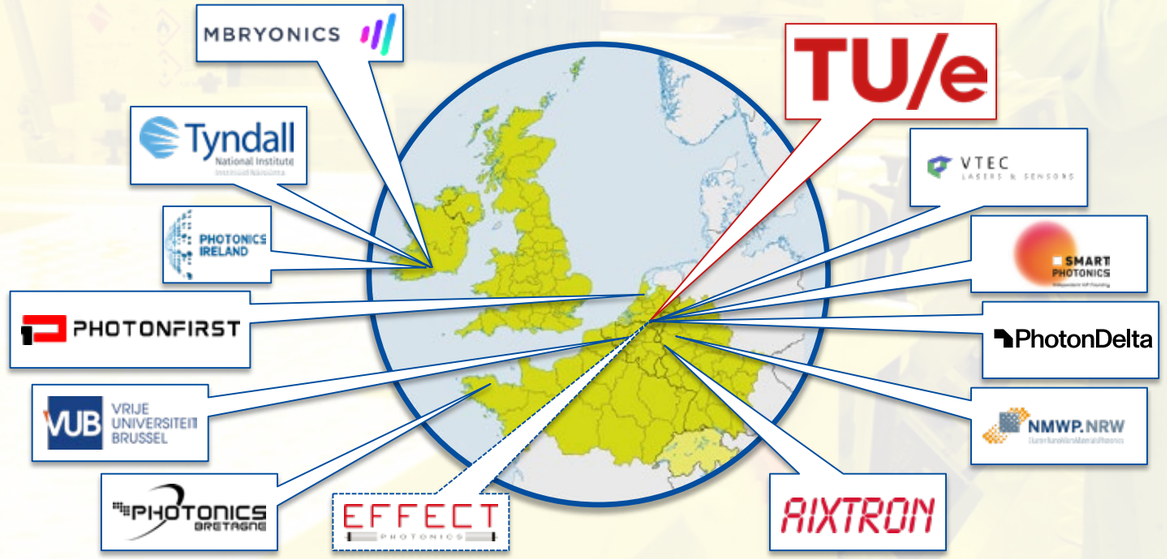


OIP4NWE – the future of the EU PIC community…

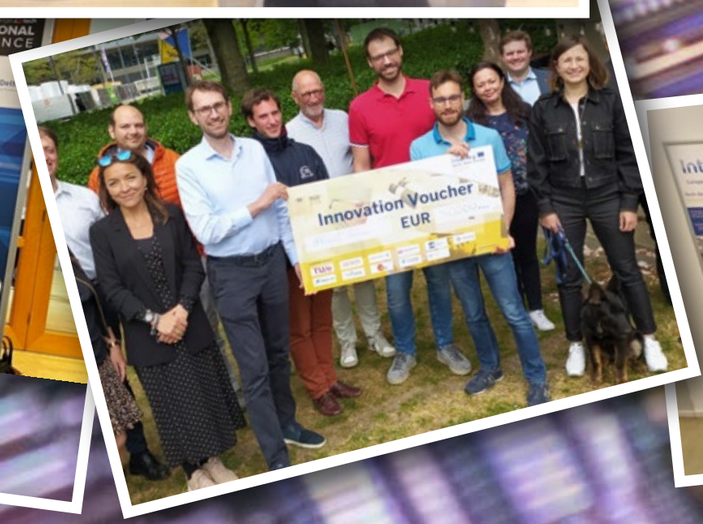
- Continue activities via the TransNational Network (TNN) to facilitate further uptake of PICs among SMEs & the sustainability of the pilot line, particularly using the network & capabilities of new agents
- Expand collaborations to consolidate the PIC pilot line, including chip fabrication and packaging technologies. To this aim, new partnerships are to be sought.

Beyond reaching to SMEs (direct & indirect business development), a critical task & groundwork is done by the partners to achieve:

- Public (national/regional) investors interested in the impact on own territory
- Private investors interested in the RoI/value-creation offered by this new emerging industry
- Key current (and future) emerging players themselves recognizing the value of a joint/harmonized collaborative strategy to build a reliable competitive horizontal supply-chain



OIP4NWE on tour...



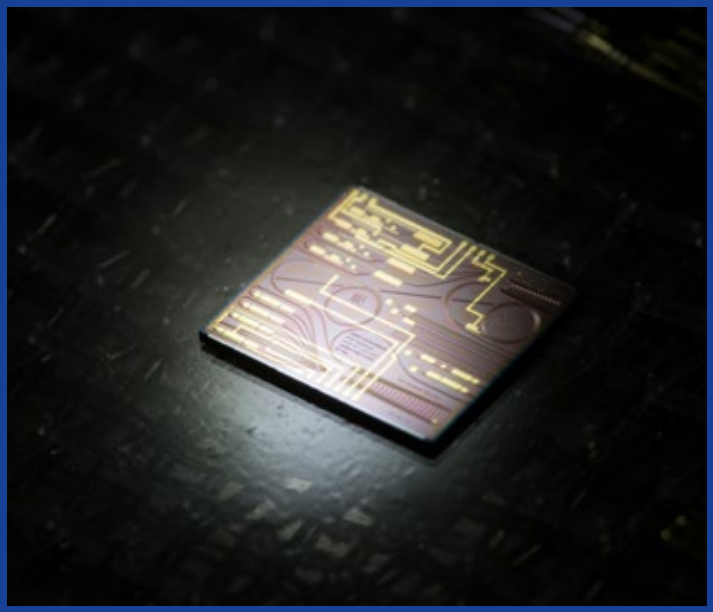
How can you be involved?

Become a cooperation partner

If you would like to benefit from the services the pilot line provides, please contact us.

Stay informed

Find more information on your participation and details of the Interreg NWE project at www.nweurope.eu/oip4nwe



Your Contact to OIP4NWE

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