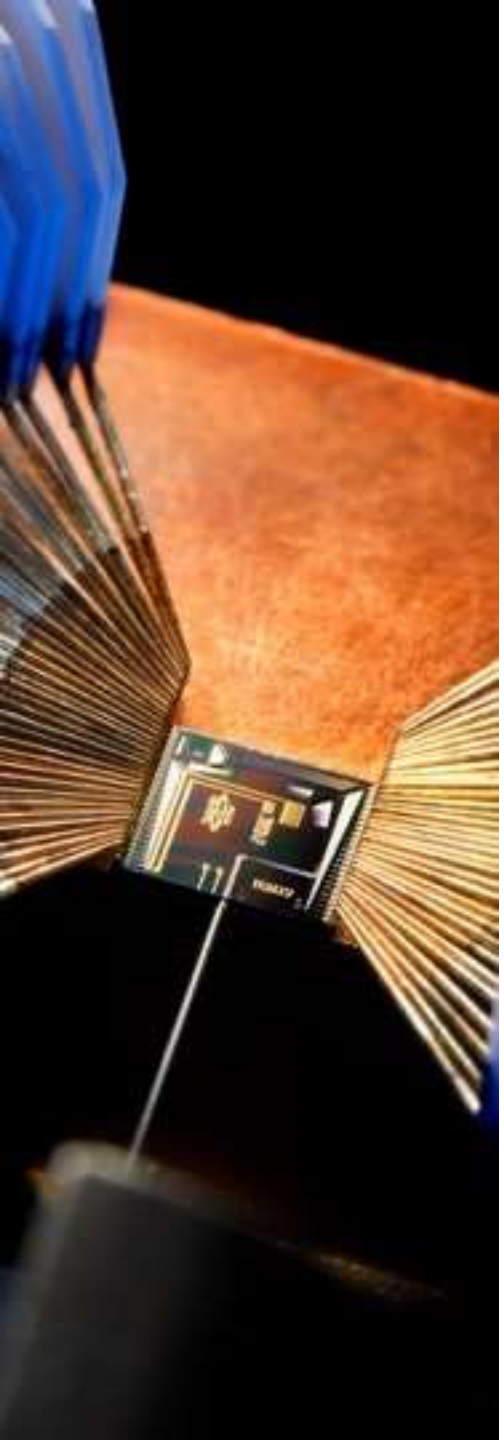
PhotonDelta

Gateway to Integrated Photonics

Integrated Photonics ecosystem

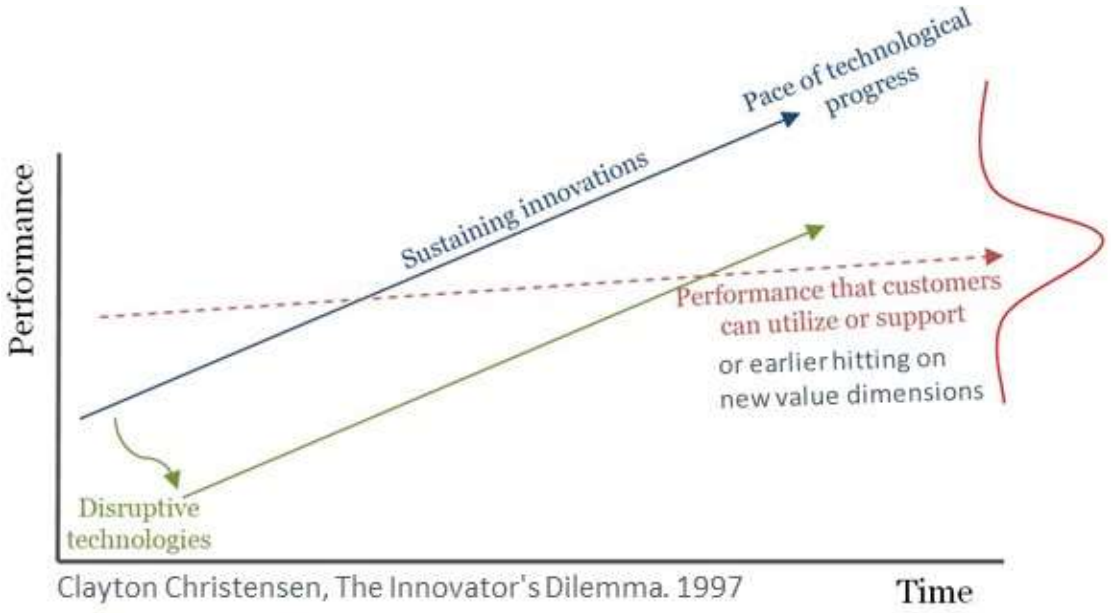
ewit roos
ceo photondelta



ABOUT INTEGRATED PHOTONICS AND ITS POTENTIAL IMPACT

PhotonDelta

…enabling disruptive solutions in multiple markets



Clayton Christensen, The Innovator's Dilemma. 1997

Disruptive Solutions Paradigm Shift

	From	To
Sensors/ Communication Devices	▶ Expensive ▶ Large ▶ Complex	▶ Affordable ▶ Small ▶ Simple
Use	▶ Expert	▶ Trained personnel ▶ Consumers
Setting	▶ Centralized, dedicated facilities	▶ In the field ▶ At home/on-the-move
Volumes	▶ Small	▶ Large


Datacom and Telecom


Medical devices and Life Sciences


Infrastructure and Transportation


Food and Agriculture

PhotonDelta

KEY OPPORTUNITIES

Datacom and Telecom

- DWDM (Dense Wave Division Multiplexing) transceivers for ultra-high (>100Gbps) data transfer at lower power consumption and cost for data centers and short-haul/metro telecom access networks
- Increased location-based dedicated capacity through RF beamforming units in satellite, mobile and wireless communications
- Small, affordable, low power free-space optical transceivers for sat-sat, sat-earth and other dedicated (e.g. building-to-building) communication links

Medical Devices and Life Sciences

- Point-of-care home diagnosis/monitoring
  - Handheld Optical Coherent Tomography
  - Label-free biosensing
- smart home devices/wearables with multiple sensing functionalities for early diagnostics, decision support or remote monitoring of at risk categories
- In-vivo intra-operative endoscopy-based surgery guidance
- Light-activated therapeutics (immunotherapy, suture)
- Life science research: e.g near-field terahertz spectroscopy

Infrastructure& Transportation

- Structural health monitoring
  - Real-time accurate sensing/monitoring of all sensible structures (buildings, bridges, dikes, oil rigs, nuclear power stations, …) and territories (e.g. earthquake prone areas)
- (Real time) control systems/automation
  - e.g. fine particle sensing in aircraft, automobiles, smart buildings
- LIDAR
  - e.g. vehicles platooning, real-time maps generation

Food and Agriculture

- Optimization food waste in food processing, transportation and distribution
- Optimization food processing equipment
- Optimization production
- Environmental characterization soil, water, (sun) light, volatiles)
- Phenotyping
- Professional/consumer end-user in-situ tools for food quality and nutrition elements monitoring

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PhotonDelta: gateway to integrated photonics

Strong acting together…

As a verticalized ecosystem enabling **leading equipment manufacturers** and **high-potential scale-ups** to **effectively** and **timely** bring to market **innovative scalable solutions** powered by our disruptive customized **Photonics Integrated Circuits and Modules**

…while nurturing individual strenghts

Each ecosystem company offering own **services** and **products** under an **open-access pure-play** model

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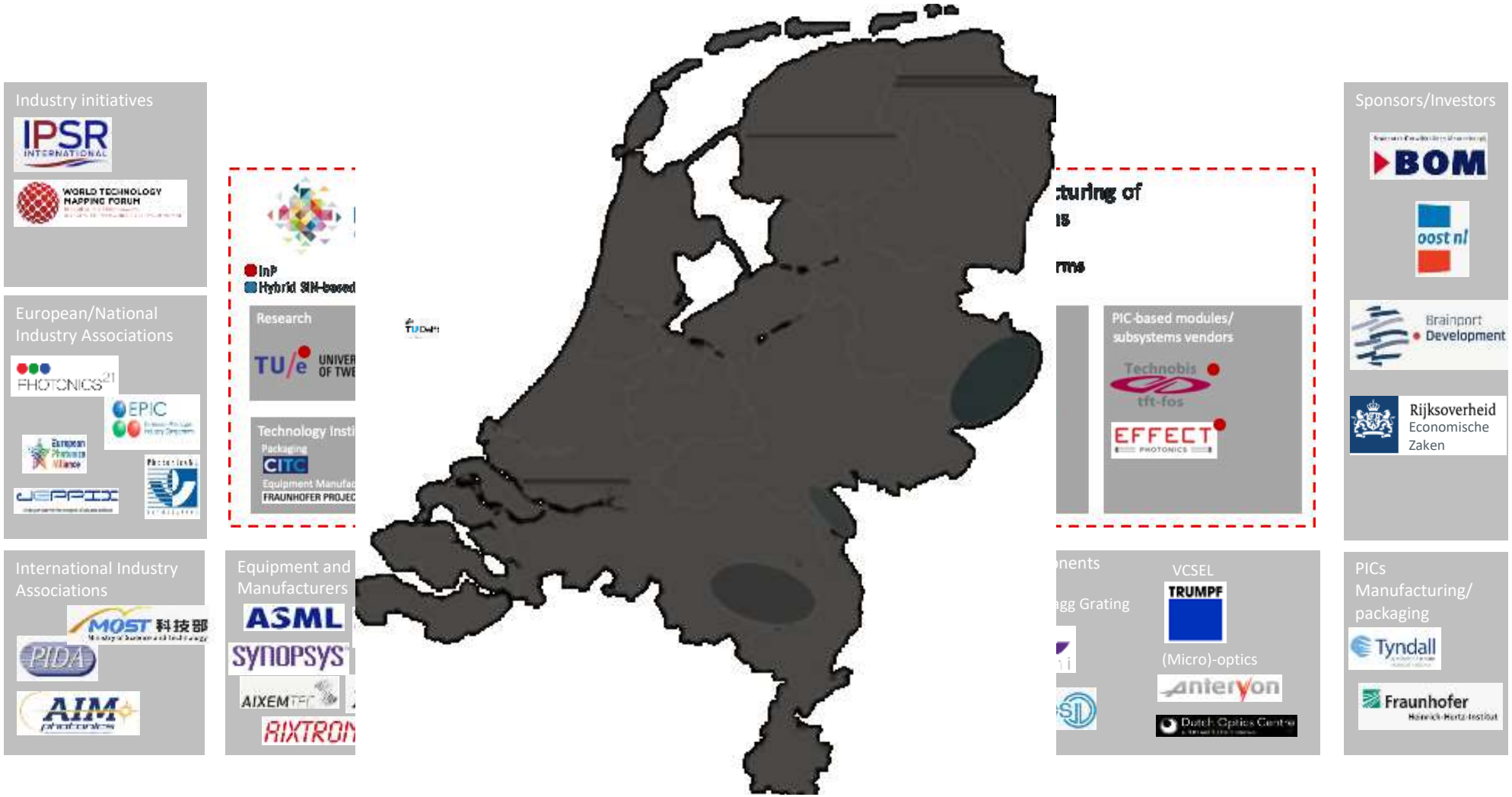
PhotonDelta ecosystem full framework

Co-operation with relevant initiatives and players around our ecosystem
Support from relevant national business development organization



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PhotonDelta Mission

Create an ecosystem of application-, design-, supply chain and knowledge institutes

Application driven companies with innovate products based on Integrated Photonics

Production Foundries with leading technology focused on both front-end and back-end

Design houses that serve customers of the ecosystem with design of applications and all elements therein (PIC, packaging etc.)

Equipment manufactures with state-of-the-art equipment for both front- & back-end production and testing

Knowledge Institutes who develop new generations building blocks, elements and production processes and train future photonics talent

Application driven companies | Supply chain companies | Knowledge institutes

Impact / Ambition

>25 companies in integrated photonics with a total annual revenue of **EUR 1 mld**

Direct employment of **~4k FTE** within integrated photonics and a multitude of connected indirect employment

Dutch focused business growth resulting from our photonics applications with an incremental effect on the entire value chain

Output serves the public interest, such as energy saving, limiting healthcare costs and improving the competitive position of the Netherlands

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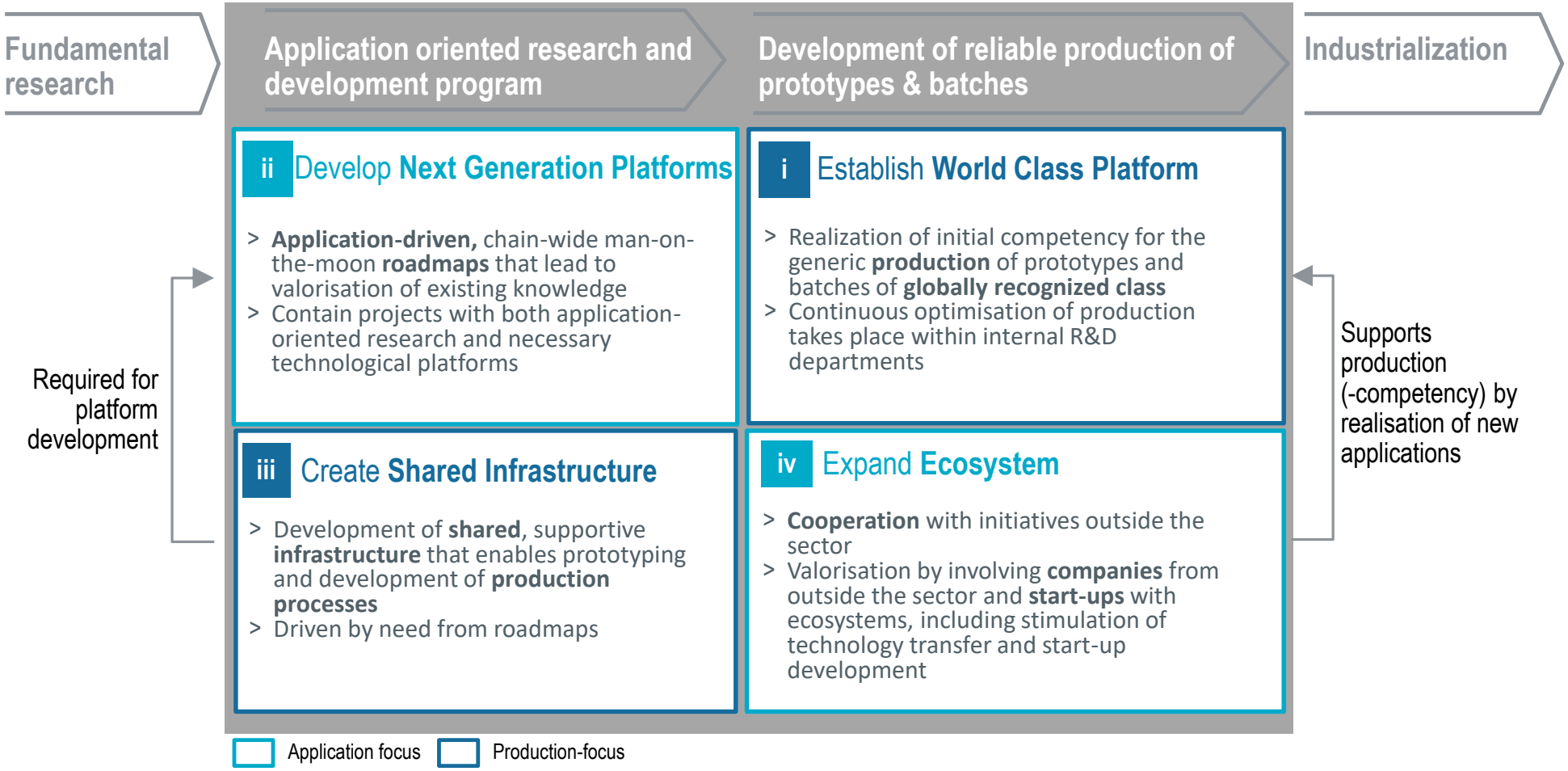
PhotonDelta long-term strategy

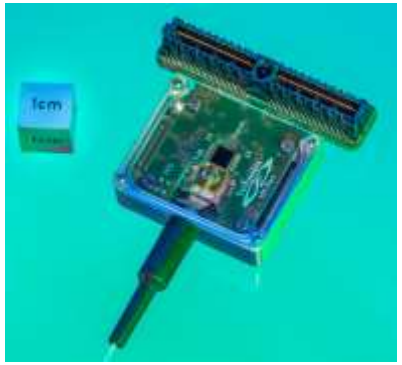
Within each pillar the entire ecosystem in scope



CLUSTER I - HIGH-TRL[1] MODULE PLATFORMS[2]
ENABLERS OF FASTER TIME-TO-MARKET AT LOWER NRE INVESTMENTS

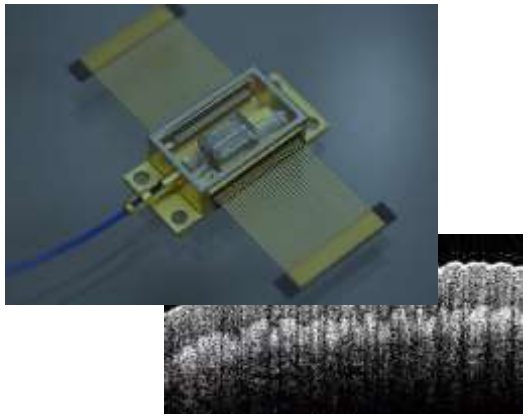
Mini-interrogator for Fiber Optics Sensing

State of the art highly accurate PICs-powered **interrogator** modules/subsystems for simultaneous **high-frequency** measurement of **force, pressure, temperature** and **relative spatial position** of distributed **sensors** over (multiple) FBG optic fibres



Broadband Ultra-narrow linewidth Tunable Lasers

Scalable, compact, low-cost low-power highly-integrated fast **dynamically** tunable lasers sub-systems with stable **high-resolution** for various frequency bands (VIS, IR C-band, NIR and MIR, for coherent telecom networks and sensing systems

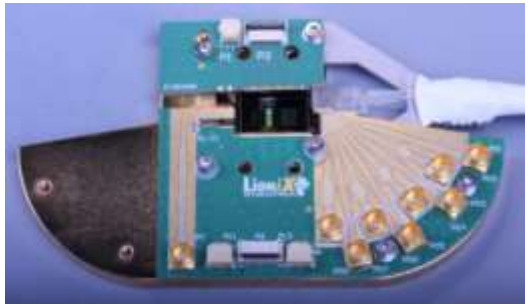


Highly sensitive Multi-parameters optical bio-sensing

Synchronized **multi-parameters** optical **sensing** subsystem, powered by proprietary (TriPleX™) integrated photonics (micro-photonics), micro/optofluidics, enabling, provided proper surface functionalization, label-free biological analysis and detection systems.

Integrated Optical Beamforming

World's first subsystem, powered by dedicated proprietary Photonic integrated Circuits (PIC) and hybrid PIC packaging, for **single/multiantenna optical-domain beamforming** in **double-digit GHz range wireless communications** (e.g. 5G mobile access points or multi-point broadband satellites)



[1]Technology Readiness Level
[2]powered by proprietary InP or SiN/TriPLeX™ Photonic Integrated Circuits

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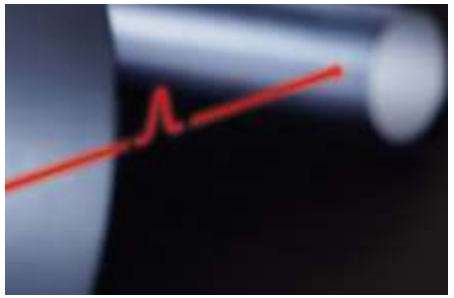
CLUSTER II - OTHER PROMISING MODULE PLATFORMS[1]

IR spectral sensing

Cutting-edge broadband NIR integrated-photonics platform based on InP co-integrated with Silicon for spectral sensing, enabling portable, non-invasive and in-line chemical analysis and phenotyping in agro-food applications

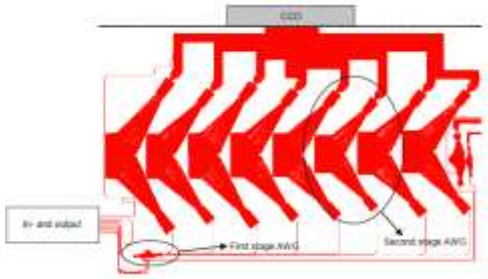
Metrology

Small footprint **µm-resolution, high-sampling frequency** distance sensor system (advanced signal processing scheme in combination with integrated photonics microwave FMCW front-end) leveraging **broad tuning range** and **fast tuning** for **absolute** measurement and **very narrow linewidth** laser for **relative** measurement.



Spectral-domain OCT

First fully integrated small-size low-cost **850nm spectral domain** fast-scan OCT module powered by a PIC containing **common path interferometer,** a **cascaded AWG-based 512 channels spectrometer** and a **broadband SLED source** and integrating a CCD **photodetector**



Environmental sensing

Small NIR-range-based sensor system (advanced signal processing scheme in combination with integrated photonics microwave FMCW front-end) for **accurate affordable detection and filtering of PM2.5 particles** in small environments (e.g cars),

[1]powered by proprietary InP or SiN/TriPLeX™ Photonic Integrated Circuits

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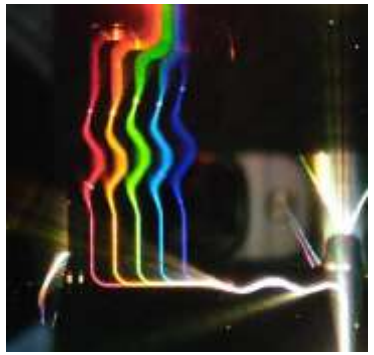
CLUSTER III - OTHER PROMISING MODULE PLATFORMS AT LOWER TRL LEVEL[1]

Ultrawideband mini-spectrometer

State of the art **VIS/NIR/SWIR** (ie 400-1700nm) integrated-photonics TriPleX™-based **minispectrometer** platforms with Arrayed Waveguide Gratings for biological tissues **sensing** and features discriminations



Waveguide-based Super Continuum Generator

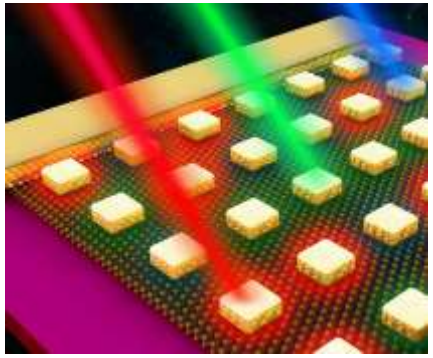
Promising approach for **low-size, low-weight, low-cost broadband "white light"** coherent light generation enabling new applications or improvement in current applications by replacing standard fiber-based coherent SCG or non-coherent sources (e.g. halogen lamps, SLEDs)

Solid state PIC-based LiDAR system

Compact and low-cost LiDAR sensor system targeting **large field of view, high angular resolution and immunity to crosstalk and vibrations.** The sensor should enable measurement of both distance and velocity of targets. Applications include automotive, avionics and robotics.

High sensitive photodetectors

Scalable, **low cost**, **high sensitive** (eg quadcell) photo detector for **compact** and **lightweight light collection** for application in e.g. free-space optical communications



[1]powered by state-of-the-art proprietary InP and/or SiN/TriPLeX™ Photonic Integrated Circuits and Packages

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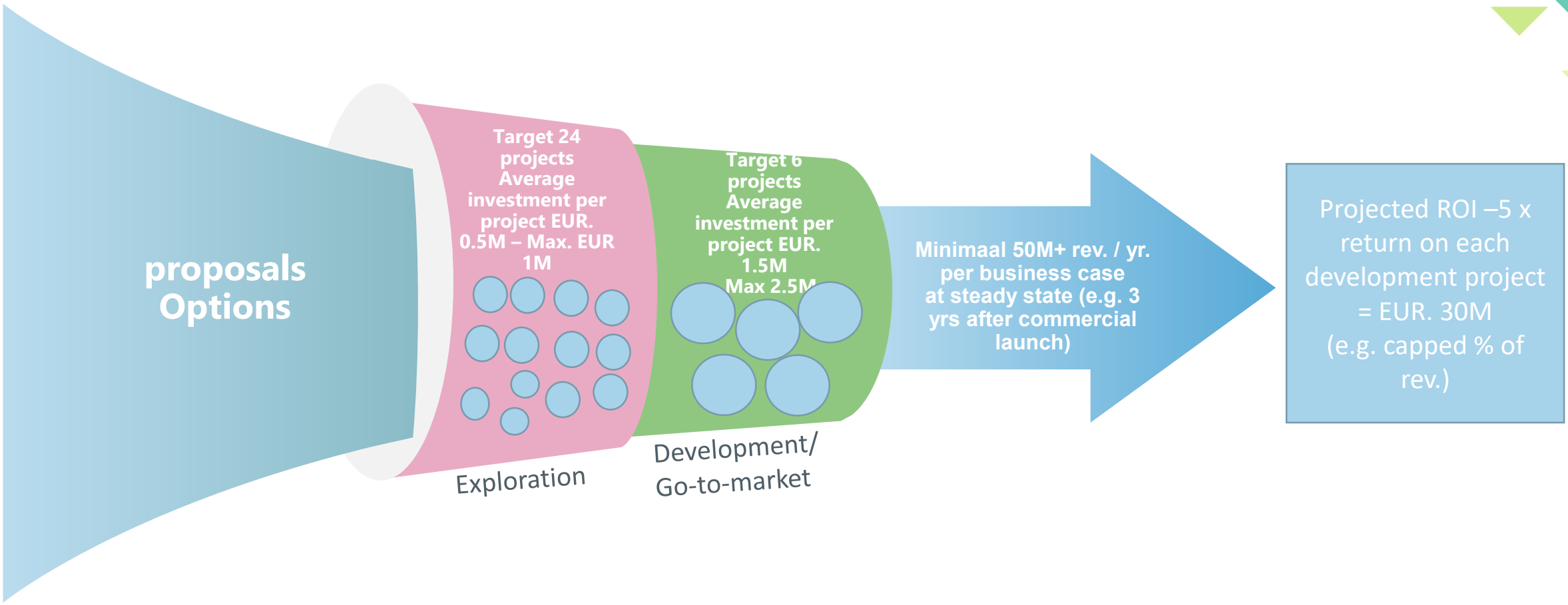
STRATEGIC CONSIDERATION FUNDING PROGRAM NEXTGEN APPLICATIONS 2019-2023



Since the start in January 2019, EUR 11.75 Mio funded, leveraging EUR 35 Mio from the market
July 2019 call: total submitted value of proposals EUR20 Mio

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ENGAGEMENT MODELS TO ACCELERATE JOINT GROWTH !

Joint ROADMAPPING

Long-term 1-to-1 partnership for the joint development of new products/solutions

- **Customers** defines requirements, develops, integrate, certifies and brings to market its solutions
- **PhotonDelta** develops, manufactures and delivers the customized PICs or PICs powered modules/subsystems matching Partners requirements

Business model: ODM/Contract R&D, possible financing of PhotonDelta ecosystem own NRE costs

APPLICATION LABS

Joint exploration for the **identification and early validation** of **options for new product/solutions**

- **Customers** brings in application domain knowledge, use-case requirements and, for early validation, testing capabilities/facilities
- **PhotonDelta** brings technology knowledge, concept definition, modeling and, for early validation, development of early stage prototypes/test platforms

Business model: Contract R&D, possible financing of PhotonDelta ecosystem own NRE costs

APPLICATION LABS BOOTCAMPS

3 full days challenge-driven bootcamp, low-threshold **closed-pockets** opportunity to leverage PhotonDelta ecosystem expertise and **bootstrap definition** of possible winning concepts to be further explored in joint projects/developments going forward

- **Customers** brings in use-case requirements
- **PhotonDelta** brings technology knowledge leading to initial definition of viable concepts

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MANY OF THOSE APPLICATIONS AND TECHNOLOGIES ARE PART OF EU FUNDED DEVELOPMENT PROJECTS

Europese projecten geïntegreerde fotonica

Project	Leidende partij	Budget allocatie [EUR m]	Positie waardeketen	TRL niveau	Partners Nederlands ecosysteem	
InPULSE	TU/e (Kevin Williams)	Σ 17,4 6,8 3,6	Open access pilot line voor opschaalbare front-end productie voor applicatie-ideeën voor InP in samenwerking met productie foundries		TU/e, Bright Photonics, Technobis, PhoeniX Software	> Doel: bevorderen van volwassen maken ecosysteem > Activiteiten: – Hoge TRL-productie op schaalbaar niveau door ontwerp aangestuurd proces – Koppeling tussen partners in het ecosysteem en partijen met een vraag voor optimalisatie technologie
JePPIX	TU/e (Katia Panina)	Σ n/a[1] n/a[1] n/a[1]	'One-stop-shop' voor ontwerp en productie van PICs in InP en TripleX voor lage TRL-niveaus d.m.v. MPW runs in samenwerking met designhouses en productie foundries		LioniX, Bright Photonics, PhoeniX Software, TU/e, Technobis	> Doel: bijdrage leveren aan ecosysteem-ontwikkeling door technologie te versnellen > Activiteiten: – MPW runs – Trainingen voor PIC-design
PIXAPP	UCC (Peter O'Brien)	Σ 13,4 2,1 0,5	Open access assembly en packaging pilot line voor PICs die al geproduceerd zijn in samenwerking met back-end foundries		TU/e, Tyndall, Fraunhofer, LioniX, PhoeniX Software	> Doel: standaardiseren van packaging voor prototype tot middelgrote productie > Activiteiten: – Aanbieden van packaging aan eindgebruikers ecosysteem – Creëren van gerelateerde ontwerpregels
Interreg North-West Europe CHAMFER	TU/e (Victor Calzadilla)	Σ 13,9 n/a n/a	Ontwikkelen van elementen/equipment ter ondersteuning van het ontwikkelen van PICs voor MKB in samenwerking met partijen uit de gehele keten		VTEC, Technobis, Tyndall	> Doel: opzetten van een open access pilot line > Activiteiten: – Front-end equipment ontwikkeling: NanoLab@TU/e – Back-end equipment ontwikkeling: Vrije Universiteit Brussel en Tyndall Institute
ACT PIXAPP	VUB Vrije Universiteit Brussel (Hugo Thienpont)	Σ 10,0 1,0 0,3	'One-stop-shop' voor start-ups voor het ontwikkelen van prototypes voor applicatie-ideëen, biedt toegang tot de universiteit		Technobis, TU/e, LioniX	> Doel: toegang bieden tot technologie voor partners in de gehele waardeketen (verwijsfunctie) binnen innovation hub > Activiteiten: – Business development/business plan ontwikkeling – Realiseren van fotonicaplatformen: 2 van de 7 specifiek voor Nederlandse geïntegreerde fotonica

Geen positie in waardeketen | Positie in waardeketen | TRL niveau | Allocatie Universiteit | 1) JePPIX is een consortium dat geen eigen begroting (meer) heeft

WHAT IS NEXT?

PhotonDelta

- RESULTS FIRST PHOTONDELTA CALL (OCTOBER 2019)
- PHOTONIC INTEGRATION TECHNOLOGY CENTER (2020)
- PHOTONICS INNOVATION HUB (MARCH 2020)
- 2 PHOTONDELTA CALLS IN 2020
- WORLD ROADMAPCONFERENCE (IPSR-I) 2020

PhotonDelta

YOU WANT TO HAVE MORE INFORMATION, PLEASE EMAIL OR CALL!

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THANKS FOR YOUR ATTENTION