PHOTONIC INTEGRATED CIRCUITS - toward new spectral ranges and new application fields
What is integrated photonics about?
**Advantages:**

- compactness
- low power consumption
- high reliability
- reduction of packaging costs
- low manufacturing and exploitation costs
Integrated Photonics at glance

Integrated Electronics

Integrated Photonics
Integrated Photonics at glance

Electronic Building Blocks
- Transistor
- Capacitor
- Resistor
- Electrical connection

Photonic Building Blocks
- Optical amplifier
- Phase shifter
- Polarization converter
- Waveguide
Generic integration technology

- MMI-couplers and filters
- MMI-reflectors
- AWG-demux
- Ring filters
- Amplitude modulator
- Fast space switch
- WDM cross-connect
- WDM add-drop
- Fabry-Perot lasers
- Tunable DBR lasers
- Multiwavelength lasers
- Ring lasers
Technological platforms of integrated photonics

- **Si (silicon photonics)**
  - Passive components and devices
  - Multichannel modulator

- **InP and related materials (InGaAsP)**
  - Active for 900–1800 nm window
  - Multichannel transmitter

- **Si$_3$N$_4$ on SiO$_2$**
  - Passive
  - Optical ring resonator

- **Hybrid/heterogeneous**
  - Combined potential of various platforms
  - Si photonic AWG with integrated photodetectors

- **GaAs**
  - Active for 600–900 nm window
  - Chip for cancer diagnose

- **Dielectric**
  - (e.g. LiNbO$_3$, RE$^{3+}$-doped)
  - LiNbO$_3$ modulators
Si (silicon photonics) passive components and devices

InP and related materials (InGaAsP) active for 900–1800 nm window

Si$_3$N$_4$ on SiO$_2$ passive

Hybrid/heterogeneous combined potential of various platforms

GaAs active for 600–900 nm window

Dielectric (e.g. LiNbO$_3$, RE$^{3+}$-doped)
### Technological platforms of integrated photonics

<table>
<thead>
<tr>
<th>Light generation and amplification</th>
<th>Indium phosphide (InP)</th>
<th>Silicon (SOI)</th>
<th>Silicon nitride (Si₃N₄)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No (hybrid integration)</td>
<td>No (hybrid integration)</td>
<td></td>
</tr>
</tbody>
</table>

| Light modulation                   | Electro-optic effect  | No electro-optic effect  | No electro-optic effect  |
|                                   | Carrier injection/depletion | Carrier injection/depletion | Carrier injection/depletion |
|                                   | Electro-absorption      | Electro-absorption       | Electro-absorption       |
|                                   | Thermo-optic            | Thermo-optic             | Thermo-optic             |
| Light detection @1550 nm          | InGaAs/InGaAsP PIN photodiodes | Ge photodiodes | No |
| Index contrast                    | Low (large bending radii) | High (small bending radii) | Moderate (moderate bending radii) |
| Propagation loss @1550 nm         | ~1-2 dB/cm              | 0.1-0.5 dB/cm            | 0.02-0.5 dB/cm           |
| Wavelength range                  | 0.9 – 1.7 µm            | 1.2 – 3.7 µm             | 0.4 – 3.7 µm             |
Si (silicon photonics)
passive components and devices

InP and related materials (InGaAsP)
active for 900–1800 nm window

Si$_3$N$_4$ on SiO$_2$
passive

Hybrid/heterogeneous
combined potential of various platforms

GaAs
active for 600–900 nm window

Dielectric
(e.g. LiNbO$_3$, RE$^{3+}$-doped)
Si (silicon photonics) passive components and devices

InP and related materials (InGaAsP) active for 900–1800 nm window

Si₃N₄ on SiO₂ passive

Hybrid/heterogeneous combined potential of various platforms

GaAs active for 600–900 nm window

Dielectric (e.g. LiNbO₃; RE³⁺-doped)

Si photonic AWG with integrated photodetectors

GaAs chip for cancer diagnose

LiNbO₃ modulators
Applications
- optical communication (fiber-optic communication systems)
- data communication (data centers)
- others
2003 - the proposal that changed the telecom market forever...

10 wavelengths

**Tx module:**
10 Laser diodes (InGaAsP)
10 modulators (LiNbO₃)
Booster amplifier (EDFA or InGaAsP SOA)

**Rx module:**
Pre-amplifier (EDFA or InGaAsP SOA)
10 photodiodes (InGaAs)
WDM system in a size of matchbox (InP technology) 2006
Early followers - data communication (silicon photonics)

Intel WDM data link - 50 Gb/s (2010)
Early followers - data communication (silicon photonics)

Intel WDM data link - 50 Gb/s (2010)
Data communication

Datacom (2020) – integrated SFP modules

100 Gb/s

100-400 Gb/s

100G QSFP28 CWDM4 Transceiver

100G QSFP28 4WDM-10 Transceiver

200G QSFP56 FR4 Transceiver (Roadmap)

400G QSFP-DD FR4 Transceiver (Roadmap)
Telecom and datacom integrated photonic market

400/800G Transceivers for NG 25.6/51.2T Datacenter Switches

1.2 Tb/s Coherent Transceiver Module (6 channels x 200 Gb/s, PM 16-QAM)

CFP2 and QSFP-DD
- optical communication (fiber-optic communication systems)
- data communication (data centers)
- others
- **High-Performance Computing**
  in-system optical interconnects, neuromorphic and quantum computing

- **Agrifood and Natural Resources**
  various types of PIC-based sensors for detecting potentially harmful molecules and substances

- **Safety and Security**
  monitoring of critical infrastructure and civil infrastructure objects, detection of explosives, chemical weapons, etc.

- **Industrial Sensing and Automation**
  sensors and imaging systems monitoring gases, liquids and solid materials, measuring thicknesses of thin films, shapes and roughness of surfaces, distances, speeds, accelerations, temperatures, pressures etc.
• Health and Wellbeing
  medical optical imaging (e.g., highly integrated endoscopes), photonic biosensors, continuous monitoring of patients' health status to detect diseases at an early stage or to continuously monitor the progression of illnesses outside a medical environment

• Mobility and Space
  with future mobility concepts that require advanced environmental sensing, in particular, components for LiDAR systems, communication systems, etc.

• Consumer electronics
  digital health monitoring, wearable systems (smartbends, smartwatches, smartphones etc. equipped with PIC sensors)
Rising field – sensing

- PHOTONFIRST
- Genalyte
- mobileye

- Optical interrogators
- SARS-CoV-2 detection
- Lidar System-On-Chip

- Biosensor-array module for drug screening
- SIPHOG™ – optical gyro
- Spectrometer-on-a-chip
Challenges and perspectives
Integrated photonics is among the most important technologies of the information society, already revolutionizing the telecom and datacom market.

Major challenges:

- scaling-up manufacturing resources,
- mass-scale generic packaging,
- electronic-photonic integration,
- new application fields and new markets!
Silicon photonic 2021-2027 market forecast

Challenges and perspectives

- Data center transceivers
- Long haul transceivers
- 5G transceivers
- Co-packaged engines
- Immunoassay
- Consumer health

2021
- $151M
- $148M
- $0.002M
- $0.1M
- $0.6M

2027
- $972M
- $240M CAGR 30%
- $1.6M CAGR 56%
- $7.2M CAGR 302%
- $2.2M CAGR 27%
- $0.4M CAGR 194%
- $1.5M CAGR 108%
- $468M CAGR 22%
- $244M CAGR 142%
- $1.7M CAGR 259%
- $5.5M CAGR 13%

CAGR 2021-2027: 36%
Integrated photonics is among the most important technologies of the information society, already revolutionizing the telecom and datacom market.

Major challenges:

- scaling-up manufacturing resources,
- mass-scale generic packaging,
- electronic-photonic integration,
- new application fields and new markets!

Extension of spectral range (towards VIS and MIR) is a must!
POLISH PERSPECTIVE
Integrated photonics @ WUT – design and technology
established in 2011
first ASPIC designed in 2012
characterization lab finalized in 2014
first ASPIC characterized in 2013
first technological trials in 2019 (CEZAMAT WUT)
first Polish Design House LightHouse established in 2022
120+ ASPIC circuits designed by EEDH, manufactured by generic foundries
Multi-wavelength transmitters for telecom and datacom

Four generations of ASPICs designed, developed and tested (TRL6)

1st

2nd

3rd

4th
Multi-wavelength transmitters for telecom and datacom

- 6 channels, L-band
- $\Delta \lambda = 0.8$ nm (100 GHz grid)
- Output power 0.2 mW
- Single mode operation, SMSR > 40 dB

Four generations of ASPICs designed, developed and tested (TRL6)
Multi-wavelength transmitters for telecom and datacom

Four generations of ASPICs designed, developed and tested (TRL6)

<table>
<thead>
<tr>
<th></th>
<th>2.5 Gb/s</th>
<th>5 Gb/s</th>
<th>10 Gb/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2B</td>
<td><img src="image.png" alt="Eye-diagram" /> ER = 10 dB QF = 9</td>
<td><img src="image.png" alt="Eye-diagram" /> ER = 9 dB QF = 8</td>
<td><img src="image.png" alt="Eye-diagram" /> ER = 8 dB QF = 6</td>
</tr>
<tr>
<td>5 km</td>
<td><img src="image.png" alt="Eye-diagram" /> ER = 7 dB QF = 6</td>
<td><img src="image.png" alt="Eye-diagram" /> ER = 7 dB QF = 6</td>
<td><img src="image.png" alt="Eye-diagram" /> ER = 6 dB QF = 5</td>
</tr>
</tbody>
</table>

- open eye-diagrams for modulation speed up to 10 Gb/s and distance up to 5 km
- error-free operation confirmed
ASPIC-based interrogator for interferometric fiber-optic gyroscope (iFOG)

ASPIC-based single-mode ring laser for ring laser gyroscope (RLG)
Integrated optical gyroscopes

IFOG system demonstrator – gyroscope experiments
Integrated interrogators of fiber Bragg gratings

Line of AWG–based interrogators (TRL6/TRL7)

- 12 channels
  - $\Delta f = 100 \text{ GHz}$
  - foundry: Heinrich-Hertz Institute

- 36 channels
  - $\Delta f = 50 \text{ GHz}$
  - foundry: Heinrich-Hertz Institute

- 44 channels
  - $\Delta f = 50 \text{ GHz}$
  - foundry: Heinrich-Hertz Institute

- 36 channels
  - $\Delta f = 50 \text{ GHz}$
  - foundry: SMART Photonics

- 36 channels
  - $\Delta f = 50 \text{ GHz}$
  - foundry: SMART Photonics

- AMZI-based interrogator
  - foundry: SMART Photonics
Integrated interrogators of fiber Bragg gratings

Line of AWG–based interrogators (TRL6/TRL7)

Demonstrators equipped with custom-made driving electronic systems
- micro-controller
- analog frontend: an array of transimpedance amplifier
- adjustable sampling rate 10 Hz – 10 kHz
- temperature control
- USB interface

ASPIC installed
- 18 channels
- $\Delta f = 50$ GHz
- foundry: SMART Photonics

ASPIC installed
- 36 channels
- $\Delta f = 50$ GHz
- foundry: Heinrich Hertz Institute
Integrated interrogators of fiber Bragg gratings
PICs technology in Poland – silicon nitride
Silicon nitride technology at WUT CEZAMAT


<table>
<thead>
<tr>
<th>Applications vs. λ</th>
<th>Silicon Nitride (SiN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violet (600 nm)</td>
<td>SiO₂</td>
</tr>
<tr>
<td>Green (550 nm)</td>
<td>SiN (~1000 nm)</td>
</tr>
<tr>
<td>Yellow (520 nm)</td>
<td>SiN (~300 nm)</td>
</tr>
<tr>
<td>Blue (450 nm)</td>
<td>SiO₂</td>
</tr>
<tr>
<td>UV (250 nm)</td>
<td>SiO₂</td>
</tr>
</tbody>
</table>

**Waveguide cross-section**

- SiO₂ (~1000 nm) and SiN (~300 nm)
- 2.0-2.3 μm thickness

**SEM image of fabricated waveguides**
Passive waveguides:

- attenuation between 1.7 and 3.7 dB/cm
- average loss (90° bend, 100 µm radius) 0.2 dB
SiN waveguides

- optical interface – butt coupling and grating coupling
- integrated structures with microfluidics interface for sensing applications
Toward mid-infrared spectral range – MIRPIC platform
Nearly all chemical vapors have a unique “molecular fingerprints” in mid-infrared
MIR photonics

- Environment protection
- Greenhouse gases emission monitoring
- Modern agriculture
- Automotive
- Special applications
- Medicine
- Security and safety
- Defense
- Internet of Things
- FSO Communication
"Photonic sensing technologies are a critical element in (...) environmental hazard monitoring"

- air quality/pollution monitoring
- water quality/pollution monitoring, including detection of chemical and micro-biological risks
- soil quality monitoring
- indoor monitoring (schools, hospitals, offices, private houses)
Kyoto Protocol:
„The Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts...”

<table>
<thead>
<tr>
<th>Greenhouse gas (Annex A of the Kyoto Protocol)</th>
<th>Chem. form.</th>
<th>Absorption lines in MIR [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Carbon dioxide</td>
<td>CO₂</td>
<td>4.3</td>
</tr>
<tr>
<td>2 Methane</td>
<td>CH₄</td>
<td>2.3, 3.3, 7.5</td>
</tr>
<tr>
<td>3 Nitrous oxide</td>
<td>N₂O</td>
<td>2.9, 3.9, 4.5, 7.7</td>
</tr>
<tr>
<td>4 Chlorofluorocarbons (HFCs)</td>
<td>CClₓFᵧ</td>
<td>13.7</td>
</tr>
<tr>
<td>5 Perfluorocarbons (PFCs)</td>
<td>CFₓ</td>
<td>7.8</td>
</tr>
<tr>
<td>6 Sulfur hexafluoride</td>
<td>SF₆</td>
<td>10.6</td>
</tr>
</tbody>
</table>
Growing demand for safer, healthier and higher quality food with smaller carbon footprint

- monitoring of the quality of air, water and soil
- monitoring of microorganisms in plants
- reduction of the use of fertilizers/pesticides
- prevention of soil degradation
- monitoring of food quality at every stage of production and distribution
- smart sensors for packages
- reduction of food wasting

- market growth of precision farming equipment and services from 3.3 billion USD in 2016 to 5.9 billion USD in 2021
Automotive

Constantly increasing number of sensors installed in modern cars, buses and trucks (including autonomous)

- monitoring of classical (combustion) and next generation (electric) engines
- in-cabin sensors
- advanced driver assistance systems (ADAS)
- thermographic cameras
- new generation LIDARs

- market growth additionally stimulated by new EU regulations
- market volume up to tens of million of units per year
Photonics provides vital components to medical technologies for the instant diagnosis of major diseases...

- breath analysis (O₂, CO₂, NO, H₂S, NH₃ and other gases, inflammation and cancer markers)
- body fluids analysis
- sweat analysis
- mobile and wearable biosensors
- smart health systems
- contactless monitoring of infants/elderly people
- nearly 10% of European GDP in 2021
- photonics in healthcare is assumed to reach 50 billion EUR worldwide
- a rapidly expanding sector
Security and Safety

Growing demand for fast and contactless detection of potential threats to people and critical infrastructure

- detection of explosive materials
- detection of toxic and flammable gases
- detection of drugs and other prohibited chemicals
- chemical & microbiological contaminations
- testing and analysis of biological and chemical samples
- identification of silent virus carriers
- food security
Billions of physical devices around the world connected to the internet

- indoor monitoring - public offices/private houses (air/water quality/contamination)
- home appliance sensors (gas/liquid analysis)
- furnace monitoring in private houses (CO₂, CO, SO₂)
- mobile/wearable sensors (medicine, sports)
- industrial processing monitoring
- large-area sensor networks in cities

A rapidly expanding sector, 6300 IoT start-ups in May 2020 (globally), prediction of up 75 bilion devices installed by 2025*
VIGO Photonics S.A. is a **photonic semiconductors** company.

The **sole European provider** of photon mid-infrared detectors, competing with Asian and US companies.

Manufacturer of **high-quality epi-wafers for photonic and microelectronic** applications based on advanced compound materials (III-V & II-VI).

On the road to **Mid-IR Photonic Integrated Circuits foundry**

- **35 YEARS ON THE MARKET**
- **220 EMPLOYEES**
- **6500 m² PRODUCTION AREA**
- **6 DETECTORS ON MARS**
started in April 2021

AIM
Development of the technology of manufacturing application-specific photonic integrated circuits (ASPIC) for MIR spectral range, providing the foundation for the first Polish PICs foundry

- **product innovation** – unique ASPICs for MIR spectra range (3.0-5.5 µm)
- **know-how** – design, development, and integration of fundamental building blocks, mastering key technologies
- **solid foundation** for the first Polish PICs foundry

Project financed by the National Centre for Research and Development in the frame of a strategic programme of scientific research „Modern materials’ technologies” - TECHMATSTRATEG III.
THE KEY ELEMENT of VIGO Photonics STRATEGY!
MIRPIC technology platform

- Laser Driver
- OCLs & ICLs
- Waveguides
- Detectors
- Ceramic Carrier
- Readout Integrated Circuit
growth technology

processing technology
Detectors – antimonide super-lattice

- InAs/InAs$_{1-x}$Sb$_x$ x=0.38 SL  p++
- $\text{Al}_{1-x}\text{Ga}_x\text{As}_{1-y}\text{Sb}_y$ barrier
- InAs/InAs$_{1-x}$Sb$_x$ x=0.38 SL  u.i.d. absorber
- InAs/InAs$_{1-x}$Sb$_x$ x=0.38 SL  N++
- GaSb buffer
- GaAs substrate

InAs/InAsSb SLs

100 nm
Waveguides – germanium

Ge-on-Si technology – modeling of passive waveguides

\[ \lambda = 5.5 \ \mu m \]
\[ W = 2 \ \mu m \]
\[ d = 1 \ \mu m \]

<table>
<thead>
<tr>
<th>d = 1 \ \mu m</th>
<th>TM0 or TE0</th>
<th>TM0 + TE0</th>
<th>Multimode</th>
</tr>
</thead>
<tbody>
<tr>
<td>W [\mu m] for ( \lambda = 3.0 \ \mu m )</td>
<td>0.7 – 0.9</td>
<td>0.9 – 1.5</td>
<td>&gt; 1.50</td>
</tr>
<tr>
<td>W [\mu m] for ( \lambda = 5.5 \ \mu m )</td>
<td>1.8 – 2.2</td>
<td>2.2 – 3.8</td>
<td>&gt; 3.80</td>
</tr>
</tbody>
</table>

TE fundamental mode
Waveguides – germanium

Ge-on-Si technology – waveguides and waveguiding components

Waveguides, tapers and bends

Multi-mode interference (MMI) couplers
Ge-on-Si technology – waveguides and waveguiding components

- Arrayed waveguide gratings (AWG)
- Grating couplers
- Distributed Bragg reflectors (DBR)
Coupling QCL lasers with germanium waveguides - first trials

Confirmed signal transmission

\[ \lambda_1 = 4.7 \, \mu m \]
\[ \lambda_2 = 5.2 \, \mu m \]
Ge-on-Si technology – characterization of waveguides and passive components

Characterization setup I
Light source: QCLs (3.7 - 5.2 μm)
Detector: InAs/InAsSb superlattice
Direct butt-coupling

Characterization setup II
Light source: QCLs (3.7 - 5.2 μm)
Detector: InAs/InAsSb superlattice
Coupling through InF₃/ZBLAN single-mode and multi-mode fibers

Waveguide attenuation below 3.0 dB/cm!

<table>
<thead>
<tr>
<th>Bending radius [μm]</th>
<th>Attenuation [dB/cm] (number of measurements)</th>
<th>Attenuation [dB/ 90° bend] (number of measurements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2.79 ± 0.57 (10)</td>
<td>0.13 ± 0.09 (8)</td>
</tr>
<tr>
<td>200</td>
<td>2.52 ± 0.11 (8)</td>
<td>0.17 ± 0.09 (10)</td>
</tr>
<tr>
<td>300</td>
<td>2.52 ± 0.16 (20)</td>
<td>0.39 ± 0.08 (19)</td>
</tr>
<tr>
<td>500</td>
<td>2.11 ± 0.46 (11)</td>
<td>0.17 ± 0.10 (14)</td>
</tr>
</tbody>
</table>
Integration with passive photonic circuits (Ge-on-Si)

First flip-chip integration tests in progress.
QCLs-waveguides integration experiments

packaging concept
<table>
<thead>
<tr>
<th>component</th>
<th>design</th>
<th>structure</th>
<th>parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waveguide</td>
<td><img src="image" alt="Waveguide Image" /></td>
<td><img src="image" alt="Waveguide Image" /></td>
<td>- attenuation 2-3 dB/cm&lt;br&gt;- spectral range 3.0 – 5.5 μm&lt;br&gt;- minimum bending radius 500 μm&lt;br&gt;- minimum WG width 0.8 μm&lt;br&gt;- Ge layer thickness 1 μm and 2 μm</td>
</tr>
<tr>
<td>Multi-Mode Interference (MMI) coupler</td>
<td><img src="image" alt="MMI Image" /></td>
<td><img src="image" alt="MMI Image" /></td>
<td>- spectral range 3.0 – 5.5 μm&lt;br&gt;- excess loss below 0.8 dB&lt;br&gt;- 1×2, 2×2 and 1×4 configuration&lt;br&gt;- asymmetric splitting ratio available</td>
</tr>
<tr>
<td>Spot-Size Converter (SSC)</td>
<td><img src="image" alt="SSC Image" /></td>
<td><img src="image" alt="SSC Image" /></td>
<td>- spectral range 3.0 – 5.5 μm&lt;br&gt;- transmission 90%&lt;br&gt;- lateral taper ($w_{out} = 8 \mu m$)</td>
</tr>
<tr>
<td>component</td>
<td>design</td>
<td>structure</td>
<td>parameters</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------</td>
<td>-----------</td>
<td>-------------------------------------------------</td>
</tr>
</tbody>
</table>
| **Grating Coupler**                           | ![Image](image1.png) | ![Image](image2.png) | - spectral range: 3.0 – 5.5 μm  
- transmission above 15% |
| **Distributed Bragg Reflector**               | ![Image](image3.png) | ![Image](image4.png) | - Bragg wavelength: 3.0 – 5.5 μm  
- reflectivity above 80%  
- tailored spectral width  
- side lobe suppression above 10 dB |
| **Arrayed Waveguide Grating**                 | ![Image](image5.png) | ![Image](image6.png) | - spectral range: 3.0 – 5.5 μm  
- insertion loss below 4 dB  
- arbitrary $\lambda$, $\Delta\lambda$ and FSR |
<table>
<thead>
<tr>
<th>component</th>
<th>design</th>
<th>structure</th>
<th>parameters</th>
</tr>
</thead>
</table>
| QCL laser                  | ![QCL laser image] | ![QCL laser image] | - spectral range 4.4 – 5.2 μm  
- pulse power 500 mW  
- pulse duration 0.2 – 1.0 μs  
- $I_{th} < 3.0$ A  
- $U < 18.0$ V |
| MCT detector               | ![MCT detector image] | ![MCT detector image] | - spectral range 2 – 14 μm  
- detectivity (room temperature) $5 \times 10^{10} - 5 \times 10^{7}$ cmHz$^{1/2}$W$^{-1}$  
- bandwidth up to 2 GHz |
| SL antimonide detector     | ![SL antimonide detector image] | ![SL antimonide detector image] | - spectral range 1.7 – 13 μm  
- detectivity (room temperature) $5 \times 10^{10} – 7 \times 10^{7}$ cmHz$^{1/2}$W$^{-1}$  
- bandwidth up to 5 GHz  
- ROHS compliant |
Next steps

- QCLs and detectors integrated with waveguides (in progress)
- First MIRPICs packaged (end of 2024)
- Line-up of technology demonstrators (on the roadmap)

<table>
<thead>
<tr>
<th>Technology Demonstrator</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSOC transmitter</td>
<td>Dec. 2024</td>
</tr>
<tr>
<td>Gas analyzer</td>
<td>Dec. 2025</td>
</tr>
<tr>
<td>Driver condition monitoring</td>
<td>June 2026</td>
</tr>
<tr>
<td>Breath analyzer</td>
<td>June 2026</td>
</tr>
<tr>
<td>Water quality monitoring</td>
<td>March 2027</td>
</tr>
</tbody>
</table>
From MIRPIC to HyperPIC
Growing global demand for semiconductors

Digital sovereignty – EC proposes Chips Act to confront semiconductor shortages and strengthen Europe's technological leadership.
HyperPIC proposal within IPCEI mechanism

Out of the comfort zone:
new technologies, new infrastructure, new knowledge, new human capital (R&D, production, management), new approach to manufacturing, big investments (IPCEI)
HyperPIC proposal within IPCEI mechanism

HyperPIC R&D partners

1. VIGO Photonics
2. Warsaw University of Technology
3. Institute of Microelectronics and Photonics SBŁ
4. Universitat Politecnica de Valencia
5. Eindhoven University of Technology
6. Politecnico di Milano
7. Tyndall National Institute
8. Silicon Austria Labs
9. Photon IP
10. Ficontec
11. KDPOF
12. TRUMPF Photonic Components
13. ams Osram
State aid: Commission approves up to €8.1 billion of public support by fourteen Member States for an Important Project of Common European Interest in microelectronics and communication technologies

The first workstream “Sense” will focus on developing novel sensors able to collect relevant analogue signals from our environment and translate them into digital data. Vigo, a Polish SME, will develop sensors in highly compact integrated circuits, replacing the current complex and large systems.

Total budget: ca. 253.4 mln EUR
Public aid: ca. 102.9 mln EUR
IPCEI – Important Projects of Common European Interest

Contract between VIGO and NCBR signed on 14th May 2024

HyperPIC – Fotoniczne układy scalone do zastosowań w średniej podczerwieni

HyperPIC – Photonic integrated circuits for applications in mid-infrared
Instead of summary
Every journey begins with a first step...
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HyperPIC is a very long journey, big challenge, a unique opportunity, and a big adventure!
Join the adventure!