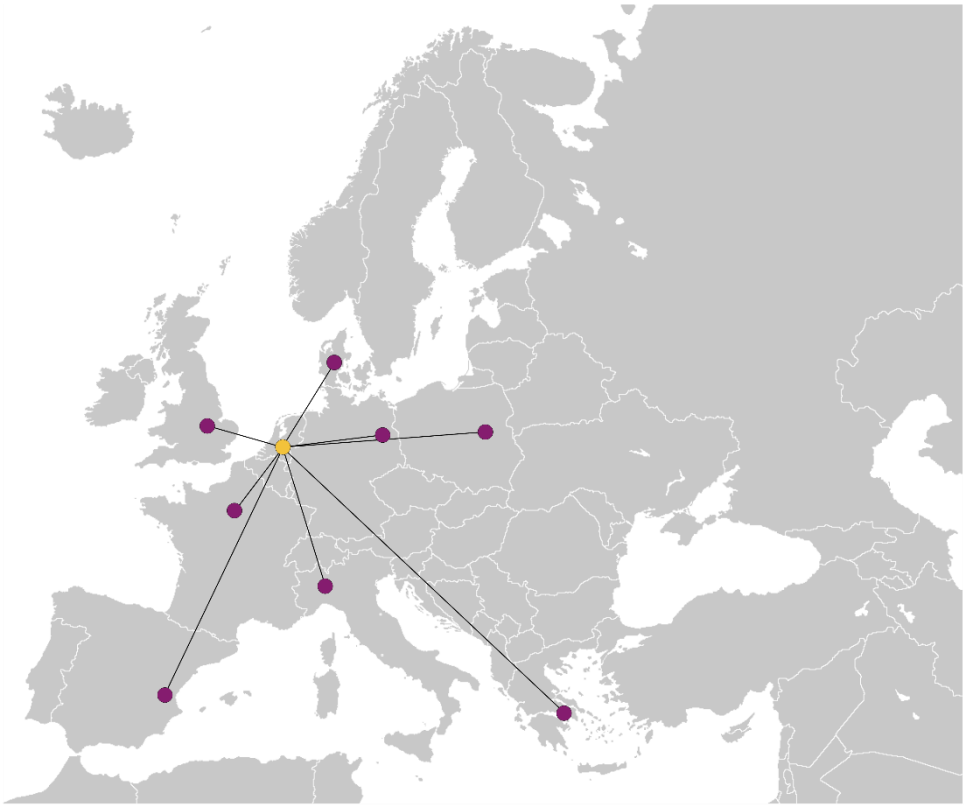
„The aim of the PICs4All CSA is to establish a European network of Application Support Centres (ASC's) in the field of Photonic Integrated Circuits (PICs) technology.

The main task (…) is to lower the barrier to Researchers and SMEs for applying advanced Photonic IC technology (…) and thus to increase the awareness of the existence of this worldwide unique facility."



coordinator

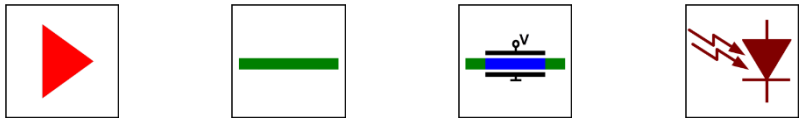
TU/e Technische Universiteit Eindhoven University of Technology

http://www.pics4all.jeppix.eu/

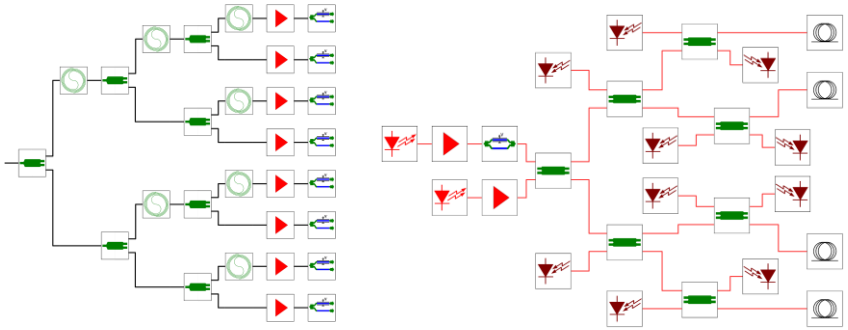
Photonic integration technology

Generic integration technology

- foundry basic building blocks

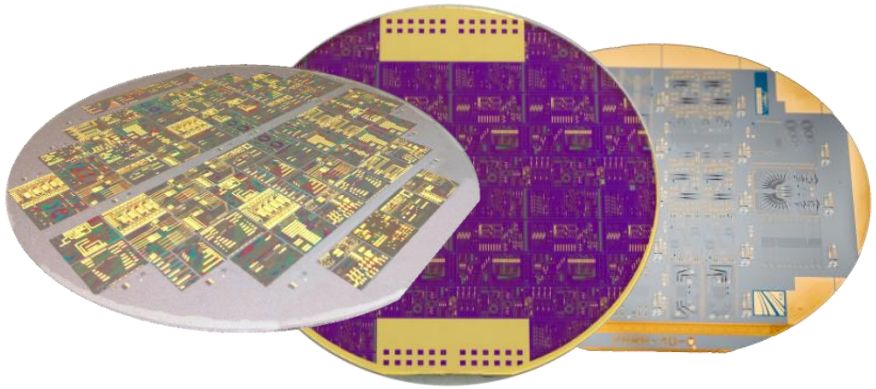


- complex photonic circuits



Multi-project wafer runs:

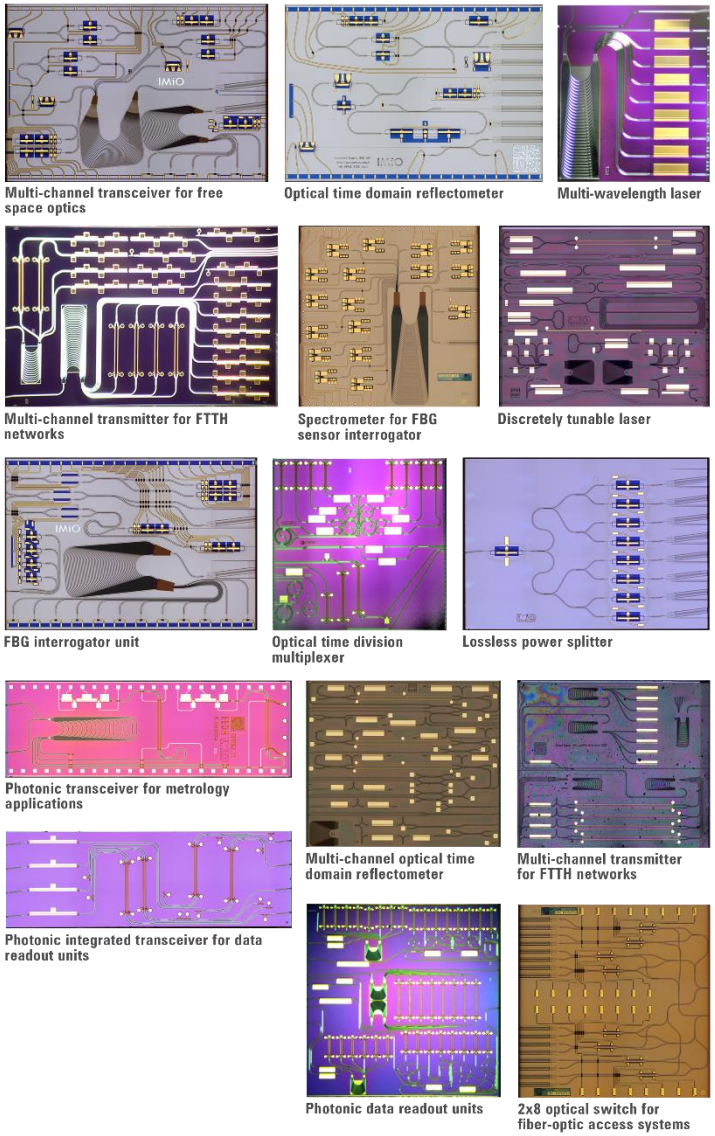
- access to cutting-edge photonic technologies
- low-cost prototyping



Photonic integration technology

Application fields:

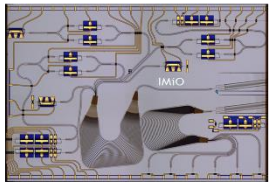
1. **Laser light sources**
   - CW lasers
   - pulsed lasers
   - ring laser
   - WDM lasers
   - tunable lasers
2. **Telecommunications and datacommunications**
   - transmitters and receivers
   - modulators and switches
   - wavelength routers
   - OTDM and WDM multiplexers
   - network monitoring systems
   - radio over fiber systems
3. **Sensors and sensor networks**
   - interrogators of fiber Bragg gratings
   - spectrometers
   - Brillouin sensors
4. **Metrology**
5. **THz techniques**
6. **Medicine**
   - optical coherence tomography (OCT)
   - bio-imaging

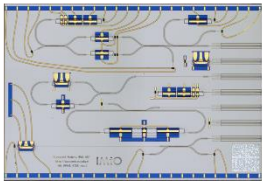


Photonic integration technology

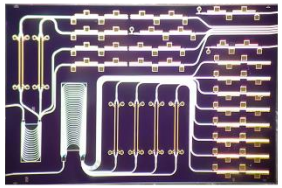
Advantages:

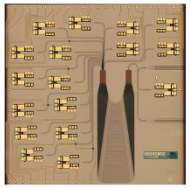
- wide range of applications
- small geometrical size, compactness
- low power consumption (economy and ecology)
- increased reliability
- low prototyping costs (MPW runs)
- low manufacturing cost (in large scale)
- reduction of packaging costs
- reduction of fiber connections
- increasingly mature and reliable technology

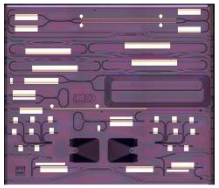

Multi-channel transceiver for free space optics

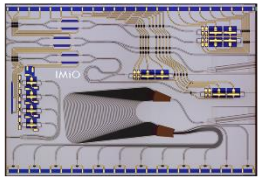

Optical time domain reflectometer

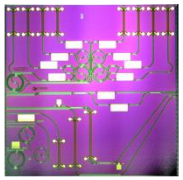

Multi-wavelength laser

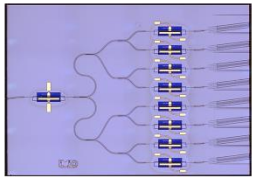

Multi-channel transmitter for FTTH networks

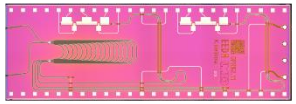

Spectrometer for FBG sensor interrogator

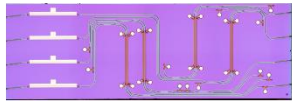

Discretely tunable laser

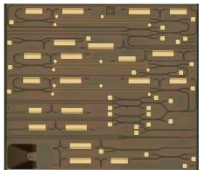

FBG interrogator unit

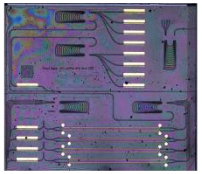

Optical time division multiplexer

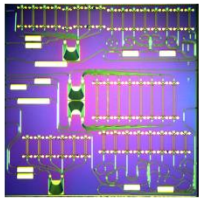

Lossless power splitter

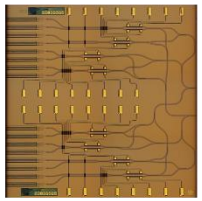

Photonic transceiver for metrology applications


Photonic integrated transceiver for data readout units


Multi-channel optical time domain reflectometer


Multi-channel transmitter for FTTH networks


Photonic data readout units


2x8 optical switch for fiber-optic access systems

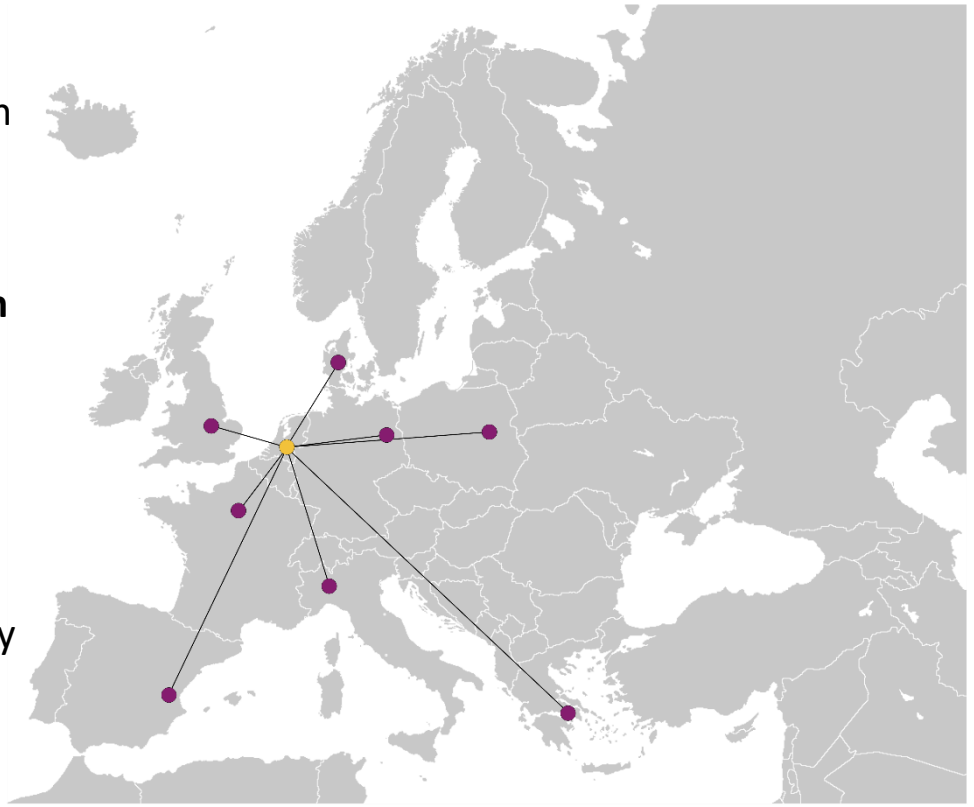
About PICs4All

Main objectives:

- **Increase the impact of photonics** and enable access to the advanced photonic integrated circuit (PIC) technologies for academia, research institutes, SMEs and larger companies.

- Establishing a European **network of Application Support Centers (ASCs)** in the field of PIC technology.

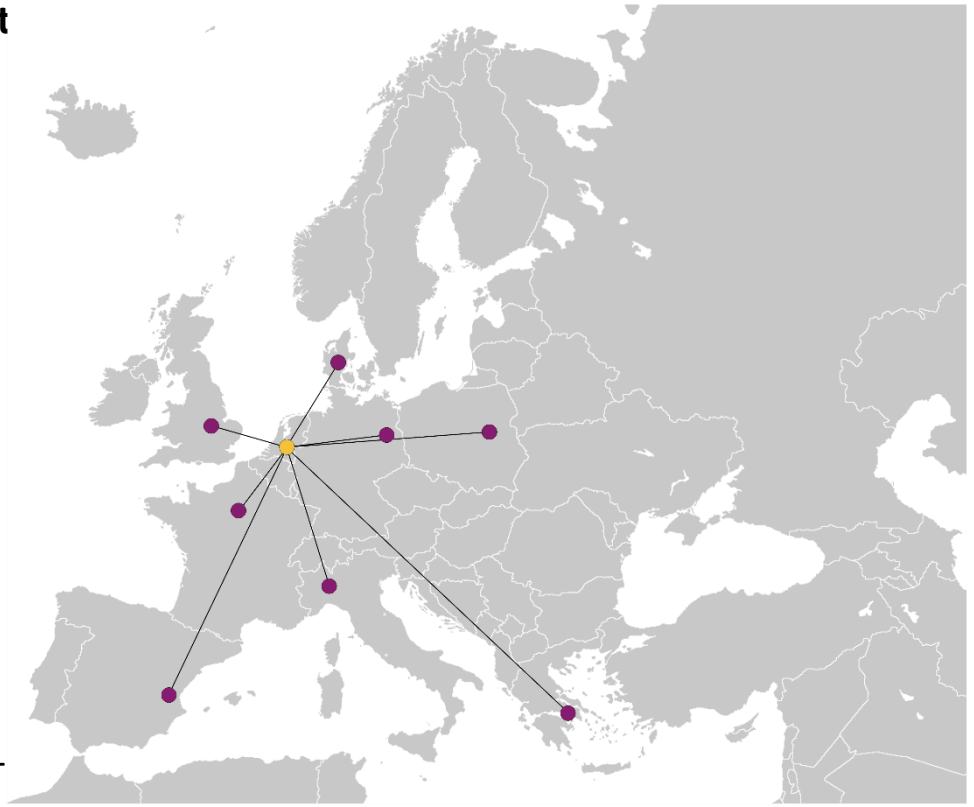
- ASCs: **to lower the barrier for applying advanced PICs**, and thus to increase the awareness of the existence of the unique facility provided by JePPIX (InP and TriPleX PIC design, manufacturing, testing and packaging).



About PICs4All

Main objectives:

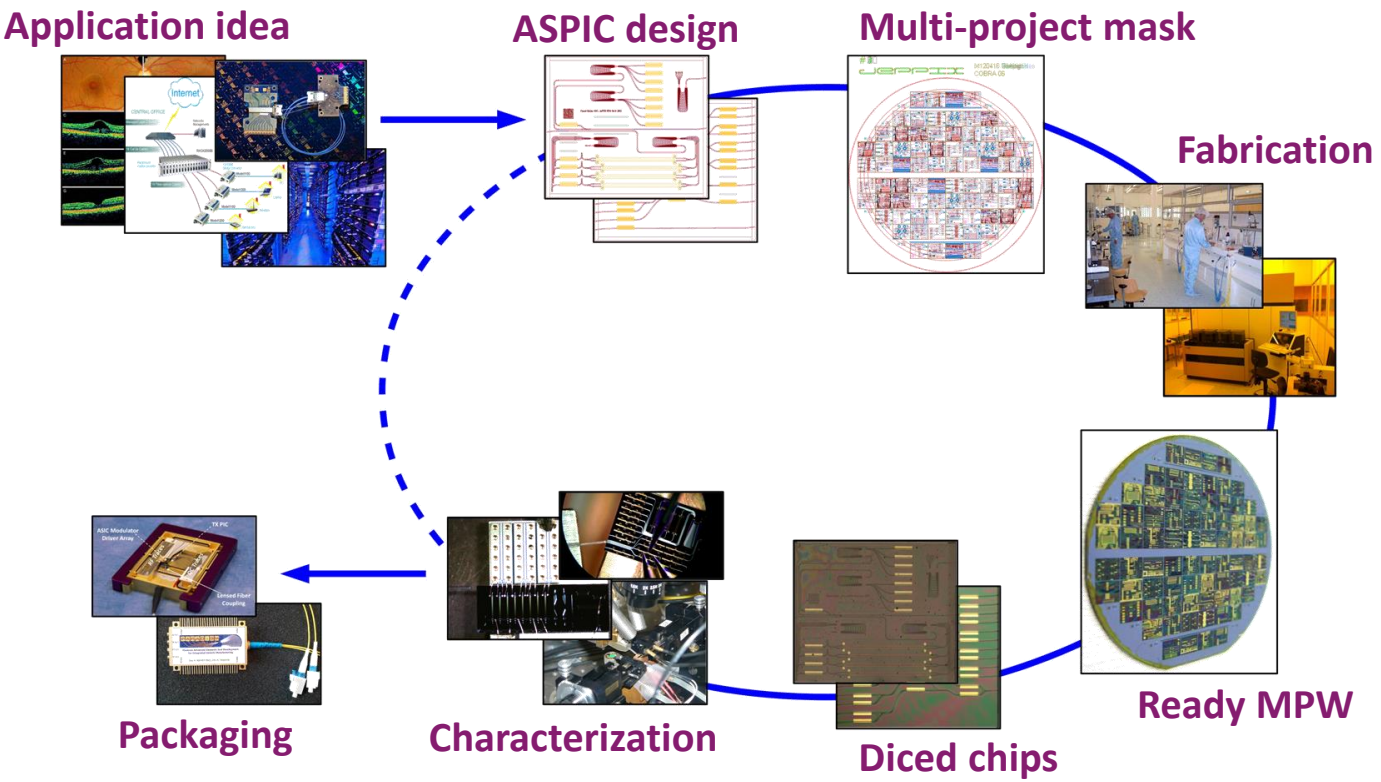
- To establish **eight photonic Application Support Centres** geographically well distributed over Europe.
- To **actively scout opportunities for the use of PICs** in new and existing applications.
- To **promote the use of the photonics technology platforms** and to increase the load of the foundries.
- **Strengthening Europe's industrial lead** in the business of integrated photonics applications and establish a significant step forward in Europe's market competitiveness in using state-of-the art InP and TriPleX technologies.
- **Bringing together academia** to explore photonics and promote its critical importance.



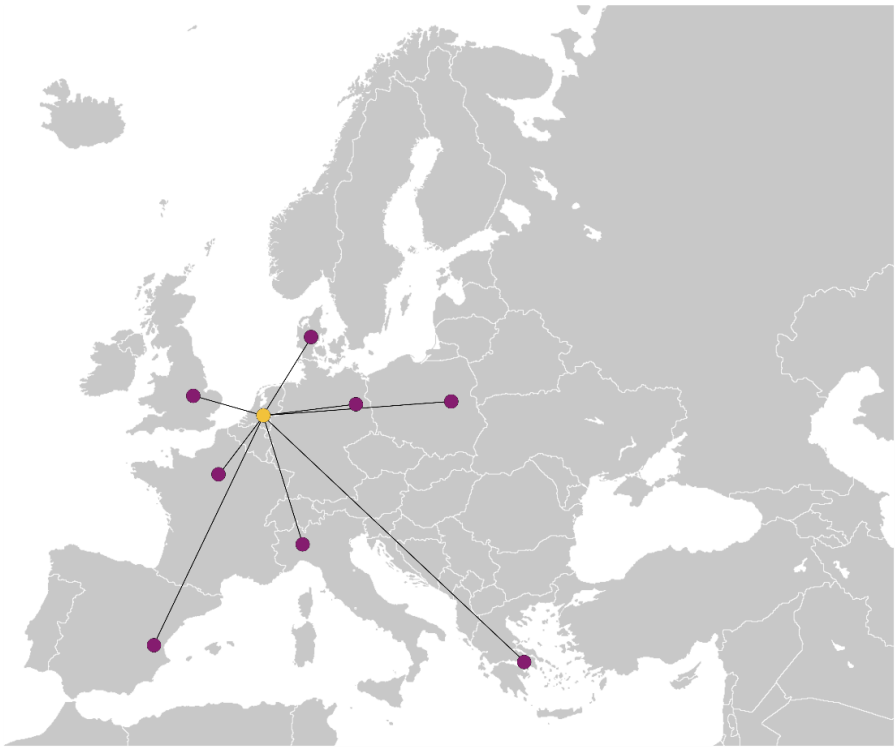
About PICs4All

Offer of an Application Support Center to external users:

- **access** to cutting edge photonic technologies
- support and guidance through all stages of the **ASPIC prototype** development process
- state-of-the-art expertise in **designing**, development and **characterization** of ASPICs – free of charge for a limited number of users

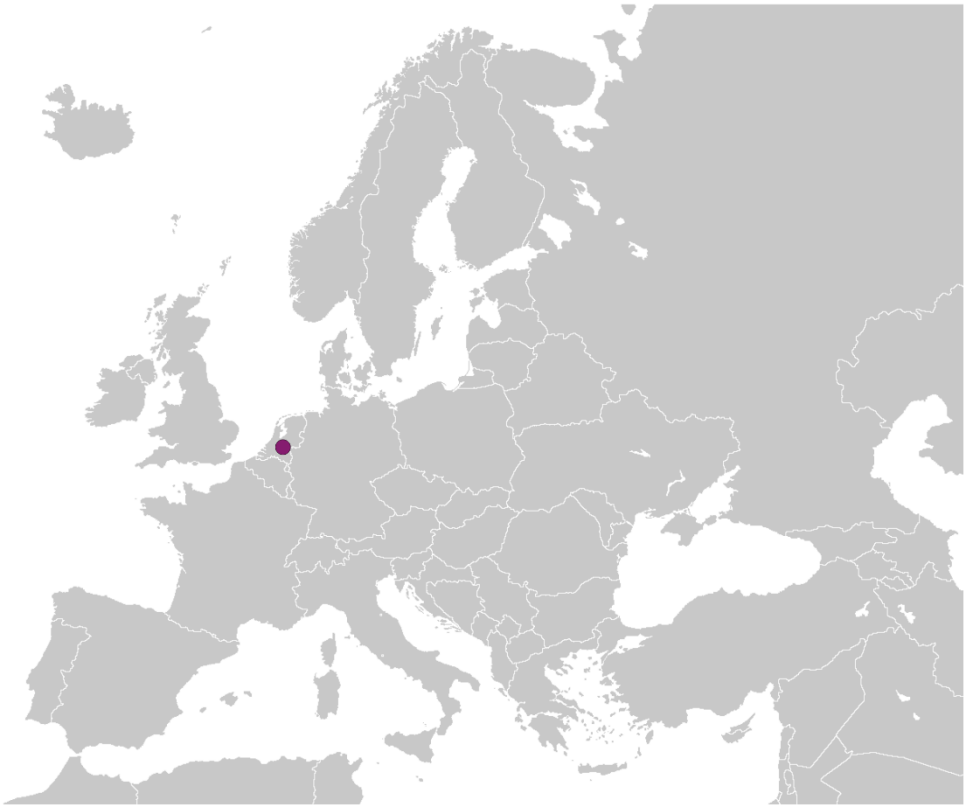


About PICs4All



Photonic integrated solutions for innovative world

Technische Universiteit Eindhoven



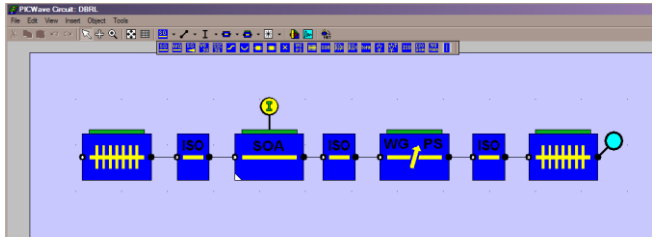
Eindhoven University of Technology
Institute for Photonic Integration
Photonic Integration Group

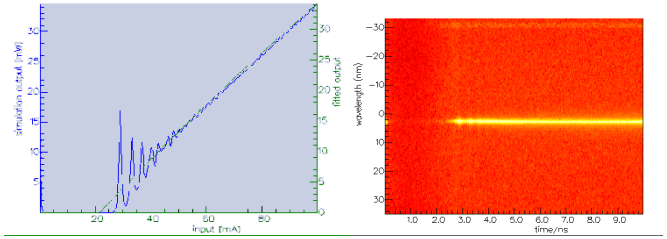
Contact person:
Katarzyna Lawniczuk, k.lawniczuk@tue.nl

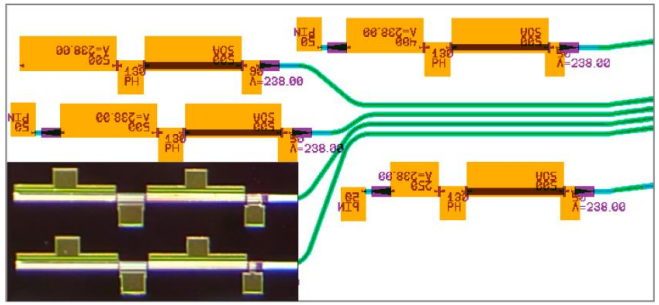
Technische Universiteit Eindhoven - expertise

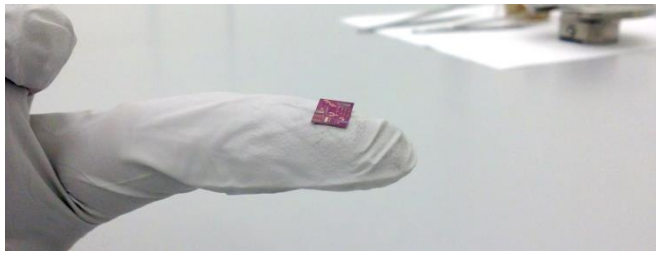
Photonic IC design

- **Access to photonic CAD software**
  - ✓ *ASPIC*
  - ✓ *Lumerical*
  - ✓ *OptoDesigner*
  - ✓ *Harold*
  - ✓ *FimmWave/Fimmprop*
  - ✓ *PICWave*
  - ✓ *VPI Photonics*
- **Experience in design of ASPICs for**
  - ✓ Telecom/Datacom
  - ✓ Sensing/Medical
  - ✓ Laser sources
  - ✓ Microwave photonics
- **Experience in using generic InP and SiN platforms**
  - ✓ Fraunhofer HHI
  - ✓ Oclaro
  - ✓ SMART Photonics
  - ✓ LioniX









Technische Universiteit Eindhoven - expertise

Photonic IC manufacturing

NanoLab@TU/e

Clean-room facilities for III-V materials

- 800 m^2 fully equipped cleanroom (ISO-class 6) with state-of-the-art equipment
- Additional labs with SEM, nano-prototyping and bonding equipment
- Separate lithography section inside the cleanroom with sophisticated equipment
- Support in epitaxy/processing of III/V
- A wide range of A(tomic) L(ayer) D(epostion) equipment

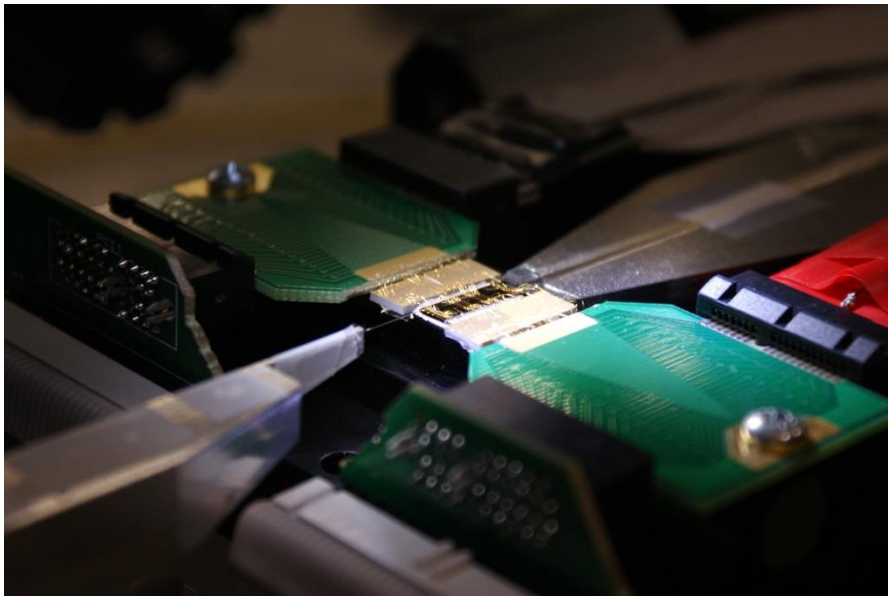
Technische Universiteit Eindhoven - expertise

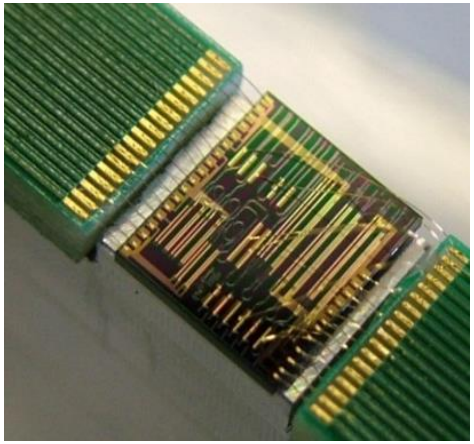
Photonic IC measurements

- Testing facilities for bare dies, complex photonic ICs and systems tests

- RF spectrum analyzers (up to 70 Gbps) and network analyzers
- BER testing sets up to 40 Gbps
- High-speed optical and electrical sampling scopes, high-speed arbitrary waveform analyzers

- Optical spectrum analyzers
- Pulsed sources, broadband sources
- Tunable laser modules S, C, L





University of Cambridge

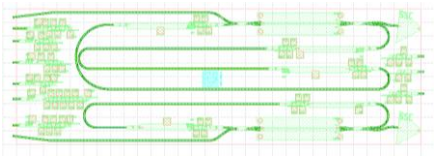
University of Cambridge
Centre for Photonic Systems

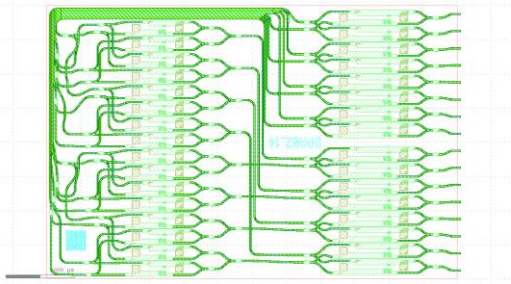
Contact persons
Adrian Wonfor, aw300@cam.ac.uk
Richard Penty, rvp11@cam.ac.uk

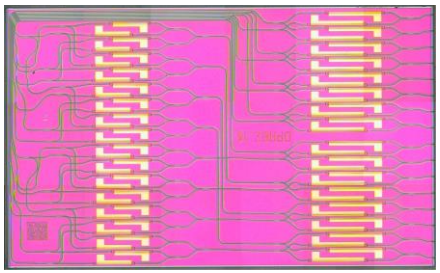
University of Cambridge - expertise

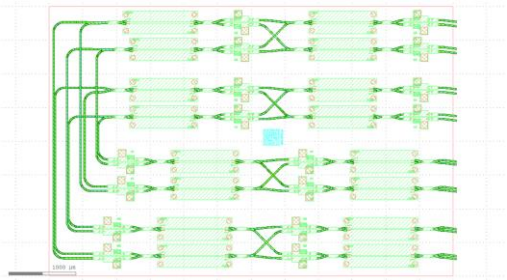
ASPIC design

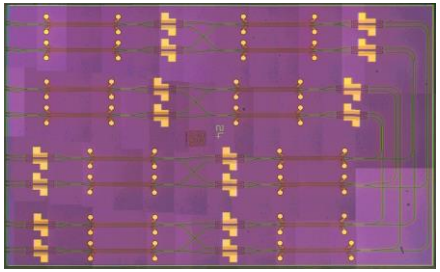
- Track record of simulation and design of ASPICs on MPW platform
- Commercial software tools
  - ✓ VPI photonics
  - ✓ PhoeniX Software
  - ✓ Photon Design
- Applications
  - ✓ Communications
  - ✓ Short Pulse Production
  - ✓ Optical Switching







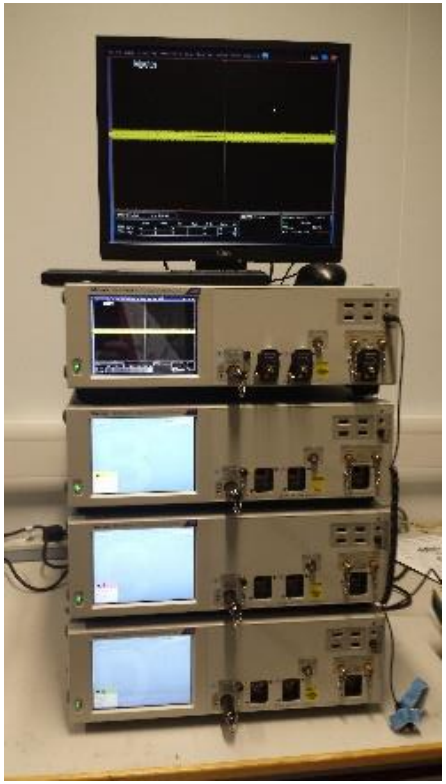




University of Cambridge - expertise

Extensive characterisation facilities

- Bare chip bonding and fibre measurement facilities
- Optical spectrum analysis and ultra-short pulse measurement systems
- RF measurements
  - ✓ RF generation and spectrum analysis to 50 GHz
  - ✓ 70 GHz VNA
  - ✓ Vector signal modulation
- Communications
  - ✓ Arbitrary waveform generation to 25 GHz
  - ✓ Multiple 70 GHz Oscilloscopes (real time and sampling)
  - ✓ 56 Gb/s BER testing
- Extensive coherent communications experience
- Connected to Cambridge and National Dark Fibre Networks



Universitat Politècnica de Valencia

Universitat Politècnica de València
Institute for Telecommunications & Multimedia Applications
Photonics Research Labs

www.iteam.upv.es

Contact person
Pascual Muñoz, pmunoz@iteam.upv.es

Universitat Politècnica de Valencia - expertise

datacom
telecom
space
instrument
bio

APPLICATION

DESIGN

photonic chip
commercial software
in house software
cluster computing
design for manufacturability

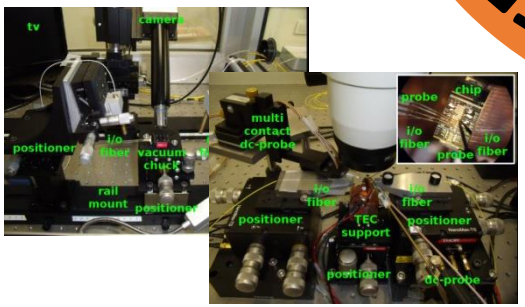
EXPLOITATION
scientific publications
patent licensing
technology transfer
spin-off company

VLC PHOTONICS

TEST

FOUNDRY

full equipped labs
systems level test
chip level test



external foundries

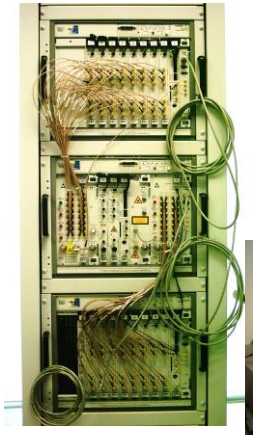
imec
cealeti
AMO
Fraunhofer Heinrich Hertz Institute
LIONIX
ocdaro
Institute of Microelectronics A*STAR

Universitat Politècnica de Valencia - expertise

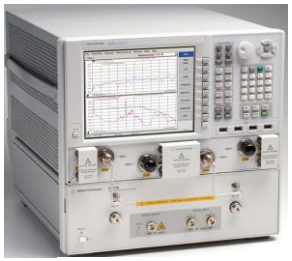
Digital and analog photonics telecom & sensing testing capabilities

The group laboratory has the last generation infrastructure for characterization of passive and active optical components, photonic integrated circuits and electro-optical devices. Thanks to its advanced facilities, experimental implementation and testing of optical communication systems, as well as, fabrication and characterization of sensors and filters over optical fiber can be carried out.

- Fiber optic characterization (attenuation, chromatic dispersion, polarization dispersion)
- Characterization of passive and active optical devices (optical modulators, optical amplifiers, filters)
- Verification of optical networks and fiber links
- Fabrication and characterization of optical filters
- Fabrication and characterization of optical sensors for building monitoring, temperature and characterization of materials
- Design and characterization of photonic integrated circuits
- Performing of fusion splicing for different types of optical fibers
- Testing of optical fiber links and electrical systems in terms of Bit Error Rate up to 43.2 Gbps





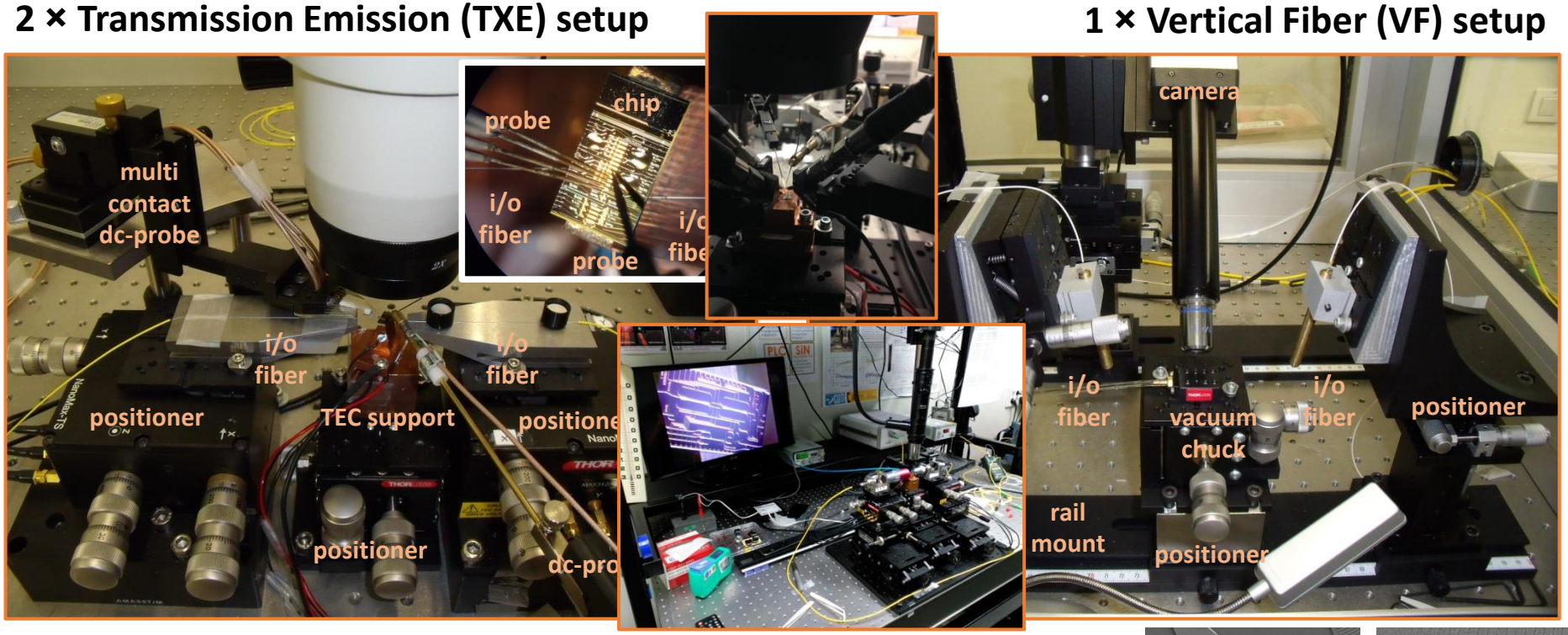



Universitat Politècnica de Valencia - expertise

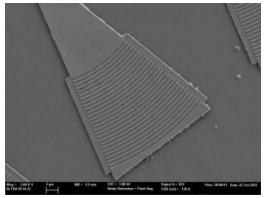
Photonic integrated circuit testing capabilities

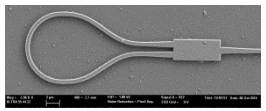
2 × Transmission Emission (TXE) setup

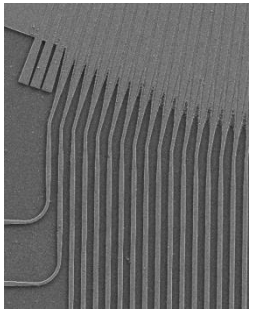
1 × Vertical Fiber (VF) setup



- 2 setups for edge coupling (TXE) and 1 setup for vertical coupling (VF)
- RF/DC probes, multi-contact wedges, lensed fibers, fiber arrays, objectives, polarizers
- Motorized translation stages, semi-automated alignment, camera vision systems
- Micro-fluidics setup for bio-photonics applications
- Visual / surface / cross-section inspection by SEM, FESEM, FIB & AFM







Politecnico di Milano

POLITECNICO
DI MILANO

Politecnico di Milano
Dipartimento di Elettronica,
Informazione e Bioingegneria
Photonic Devices Group

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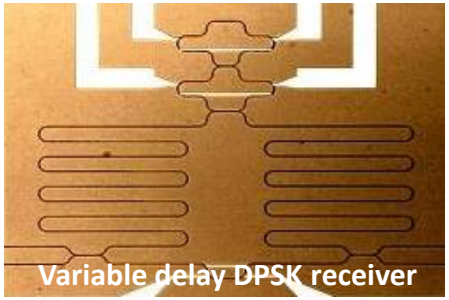
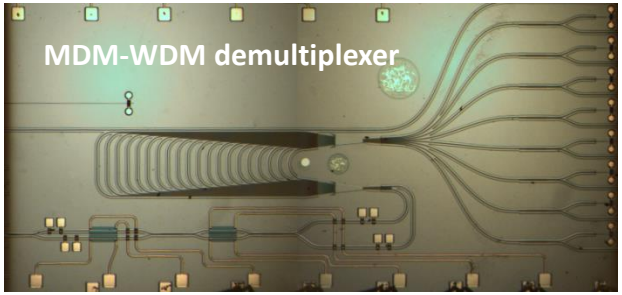
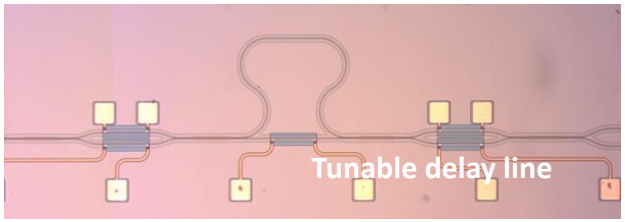
Contact persons
Daniele Melati, daniele.melati@polimi.it
Andrea Melloni, andrea.melloni@polimi.it

Politecnico di Milano - expertise

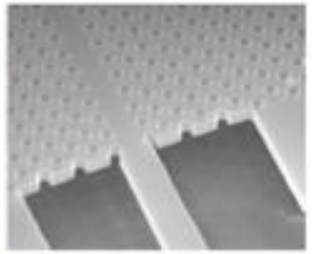
Optical Communications



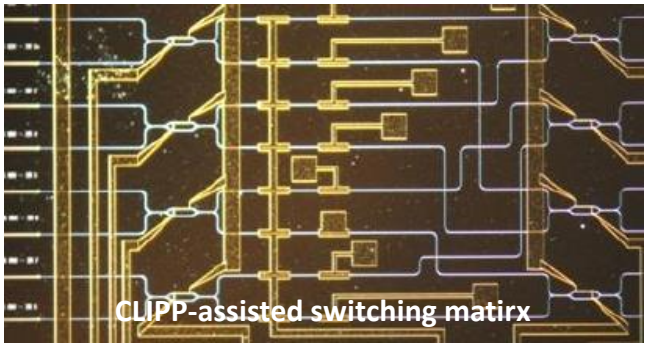


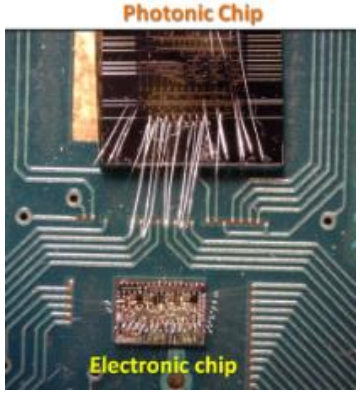


Slow light

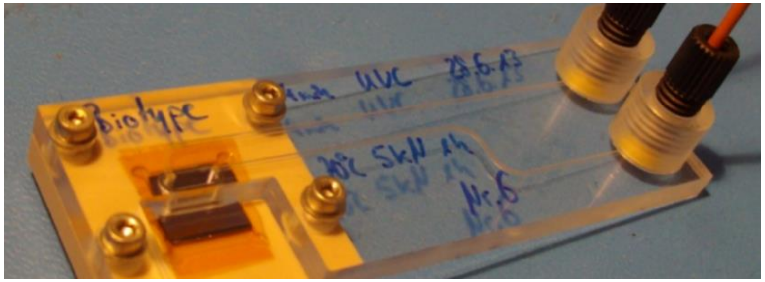


Circuit control and locking

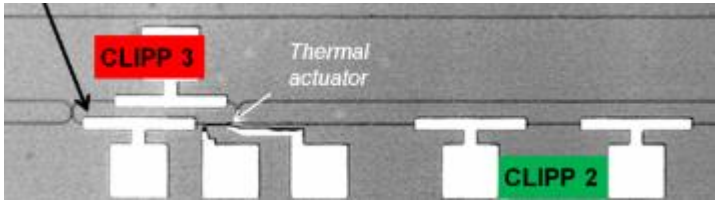




Biosensors

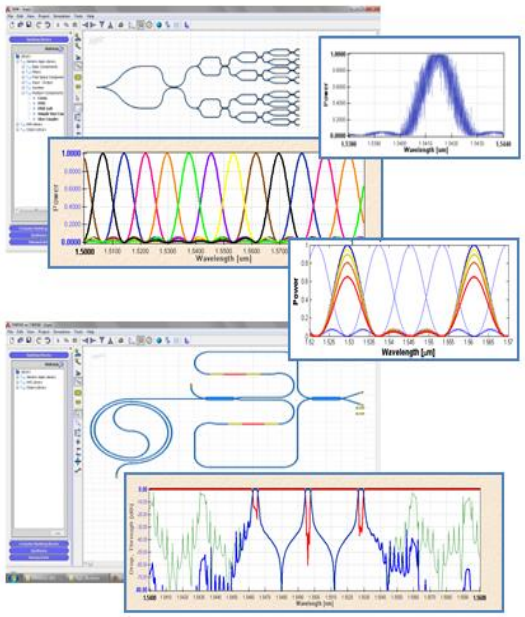


Novel devices

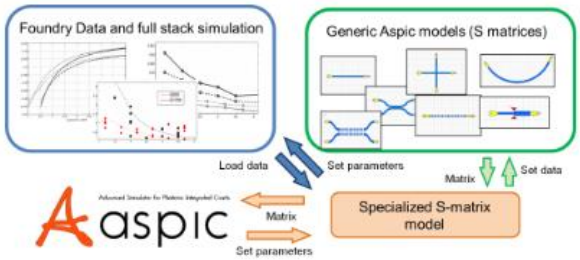


Politecnico di Milano - expertise

Circuit simulation



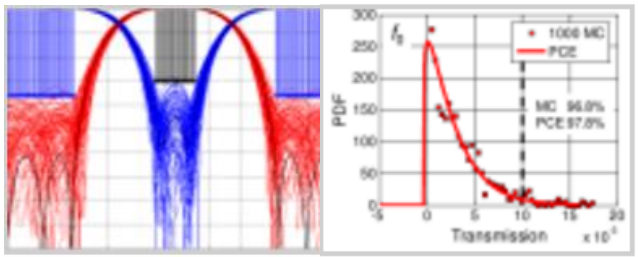
Process Design Kit



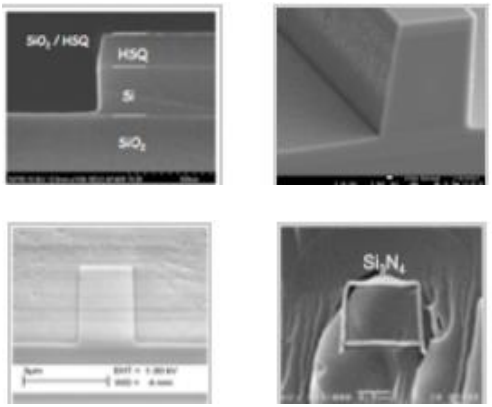
Cleanroom

polifab
POLITECNICO DI MILANO

Stochastic methods

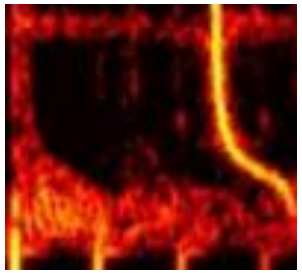


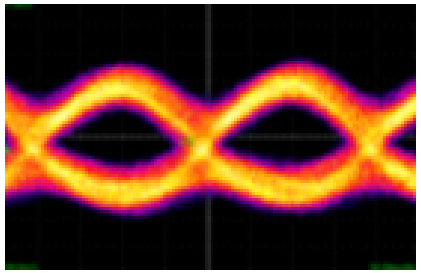
Many technologies



Ge:SiO_2, SiON, Si_3N_4, TeO_2, $LiNbO_3$, InP, Chalcogenide, Silicon (SOI)

Advanced charaterization





OFDR, time domain, spectral characterization, material analyses

Warsaw University of Technology

Warsaw University of Technology
Institute of Microelectronics and Optoelectronics
Eastern Europe Design Hub

e-mail: aspic@imio.pw.edu.pl

Contact persons:
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Stanisław Stopiński, s.stopinski@imio.pw.edu.pl

Warsaw University of Technology - expertise

ASPIC designing

- **Access to photonic CAD software**
  - ✓ *OptoDesigner*
  - ✓ *PICWave*
  - ✓ *ASPIC*
- **Experience in design of ASPICs for**
  - ✓ telecommunications
  - ✓ sensing systems
  - ✓ data readout
- **Experience in using generic InP platforms**

PhoeniX Software
Solutions for Micro and Nano Technologies

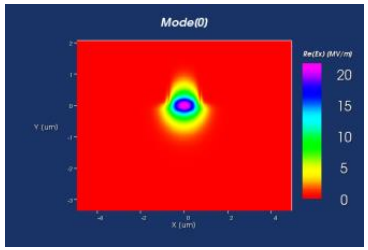
aspic

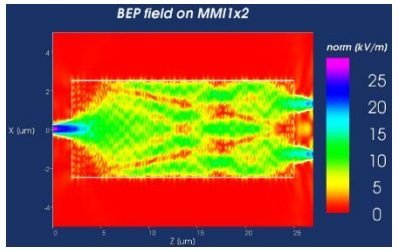
Photon Design

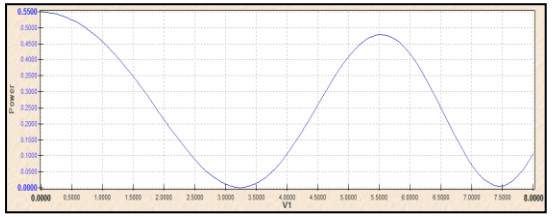
SMART Photonics
III-V foundry services

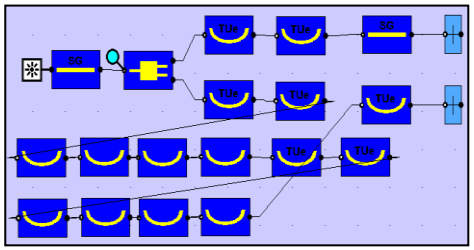
Fraunhofer
Heinrich Hertz Institute

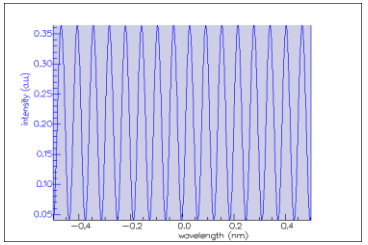
OCLARO

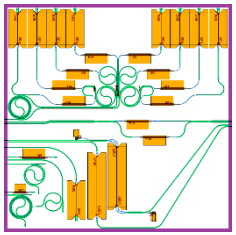


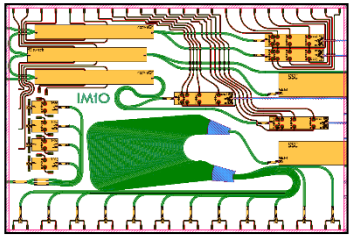


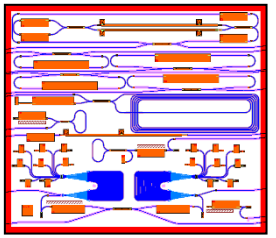






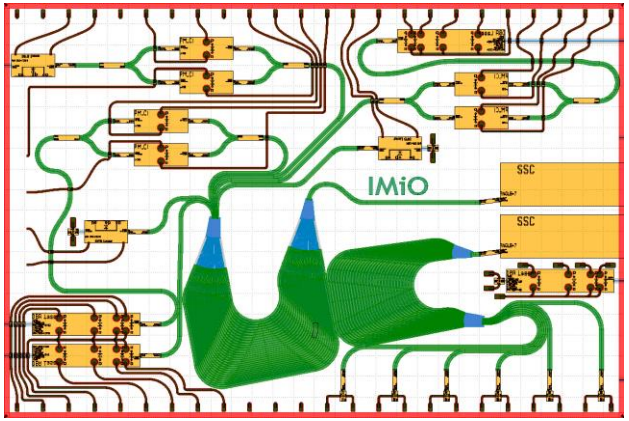


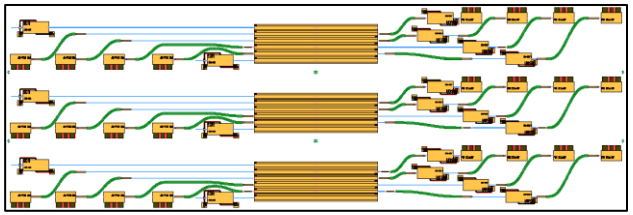


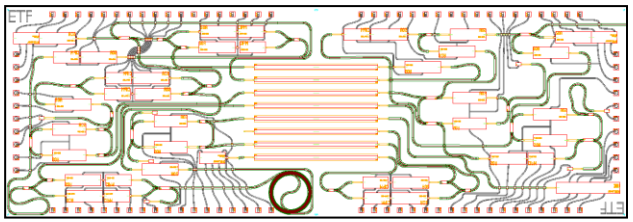


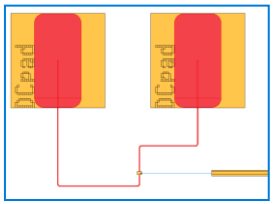
Warsaw University of Technology - expertise

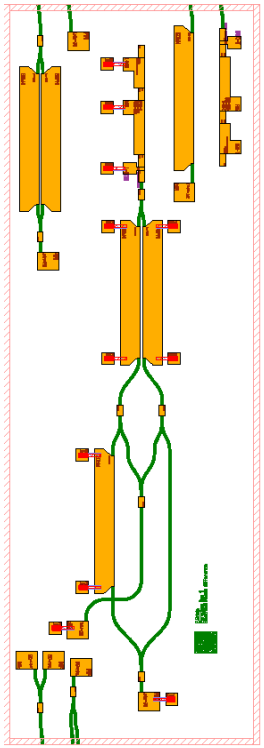
ASPIC designing

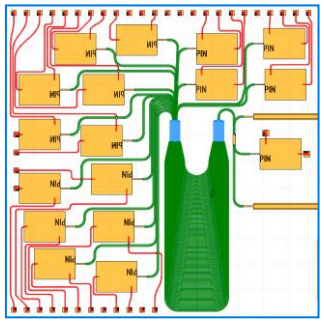


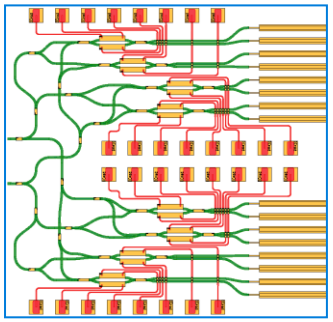


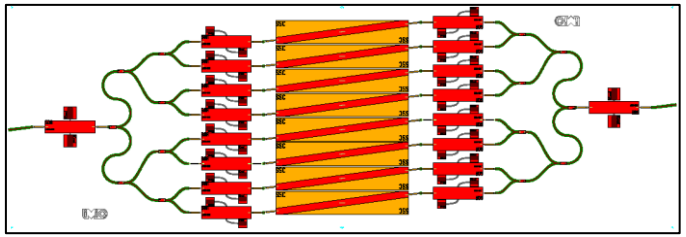


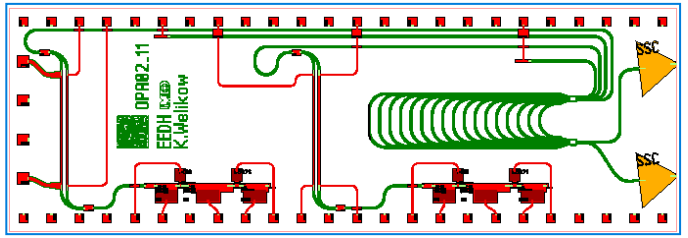


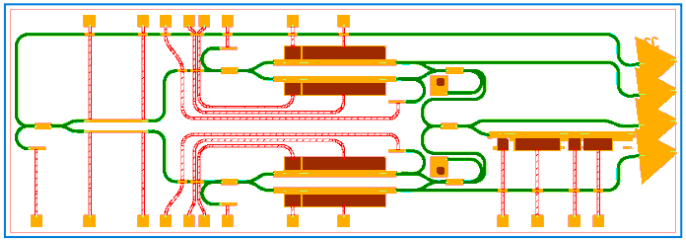






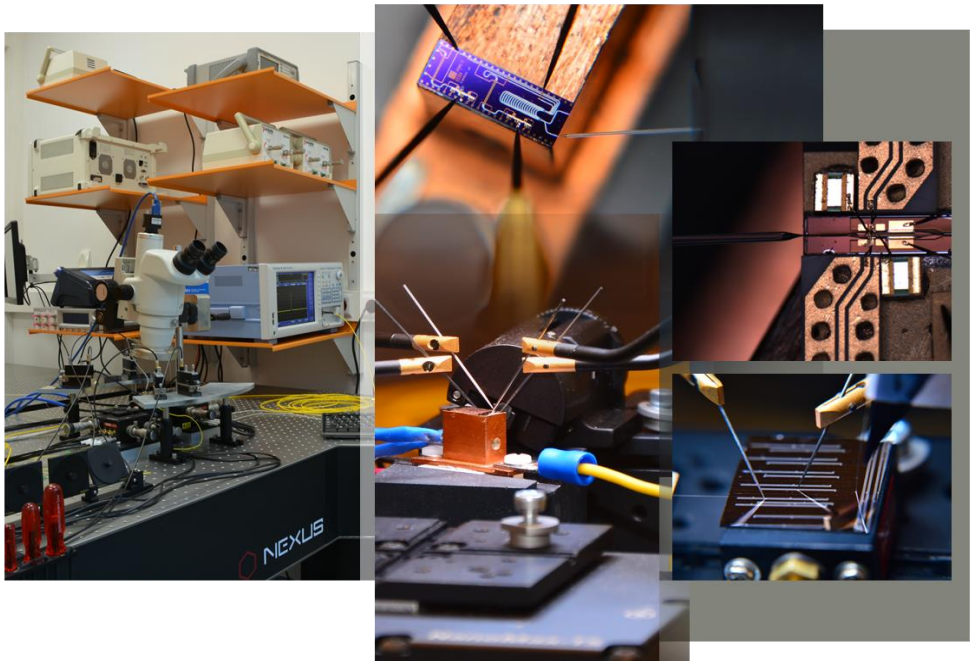






Warsaw University of Technology - expertise

ASPIC characterization



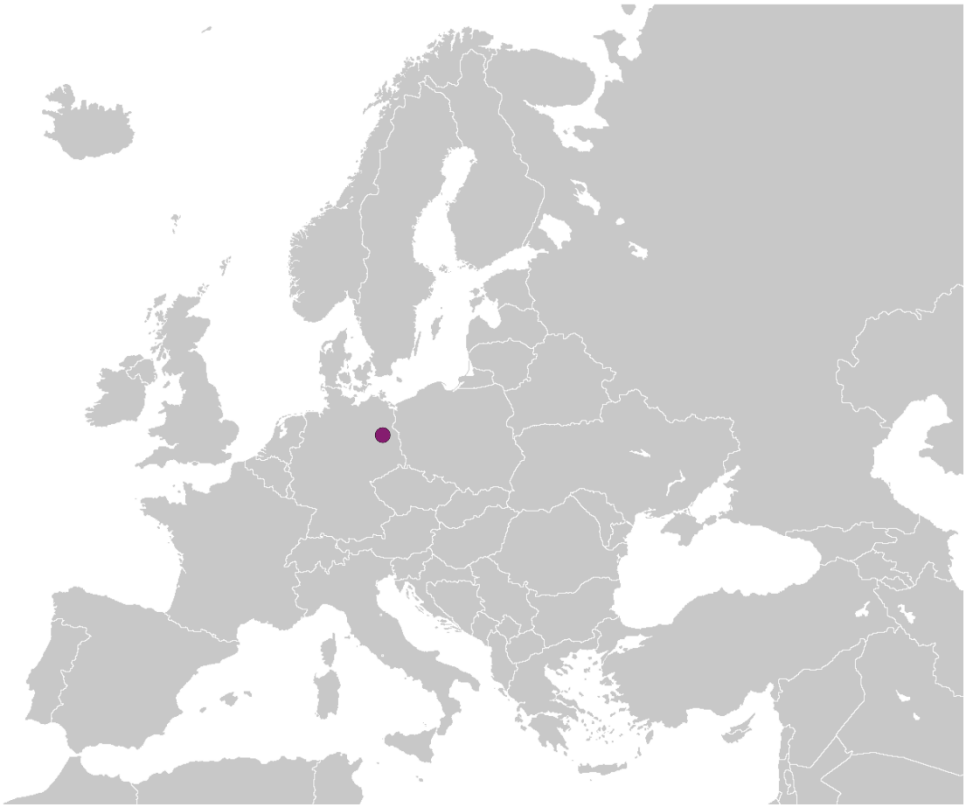
- Packaged passive and active chips
- Electrically submounted active chips
- Unpackaged passive and active chips

- **Lasers** – output wavelength (res. 0.1 pm), optical spectra (up to 3400 nm), output power (from -110 dBm up to 10 dBm);
- **Detectors/receivers** – wavelength response;
- **Multichannel devices** – spectral characteristics, crosstalk, signal to noise ratio, time domain characteristics, eye-patterns (>40 Gbps);
- **Passive devices** – spectral attenuation, insertion losses, PDL;
- **Optical amplifiers** – gain, spectral characteristics of the gain, noise figure;
- **Complex circuits** – combination of the above mentioned parameters, analysis of the chip losses by optical backscattering reflectometry;
- **RF characterization** – optical and electrical (up to 40 GHz).

Warsaw University of Technology - expertise

Dissemination of knowledge - conferences, workshops, trainings

Technische Universität Berlin



Technische Universität Berlin
Chair for Optics and Optoelectronic Integration

Contact persons
Moritz Baier, baier@campus.tu-berlin.de
Martin Schell, martin.schell@tu-berlin.de

Technische Universität Berlin - expertise

ASPIC designing

- **Access to photonic CAD software**
  - ✓ *OptoDesigner*
  - ✓ *PhotonDesign Tools*
  - ✓ *VPI TransmissionMaker*
  - ✓ *Lumerical Tools*
- **Experience in design of ASPICs for**
  - ✓ telecommunications
  - ✓ sensing systems
  - ✓ data readout
- **Experience in using generic InP platforms**

Fraunhofer Heinrich Hertz Institute

PhoeniX Software
Solutions for Micro and Nano Technologies

Photon Design

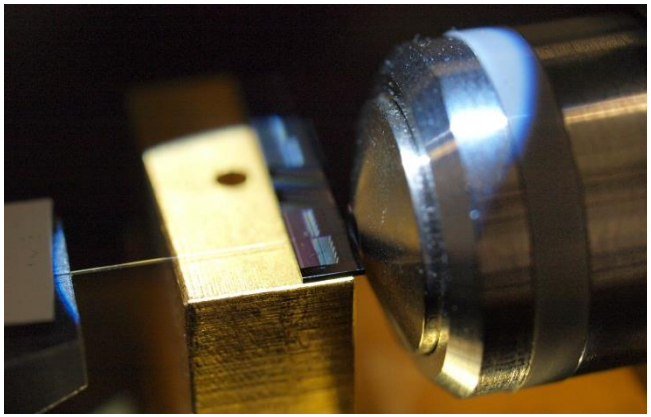
VPIphotonics DESIGN AUTOMATION

lumerical

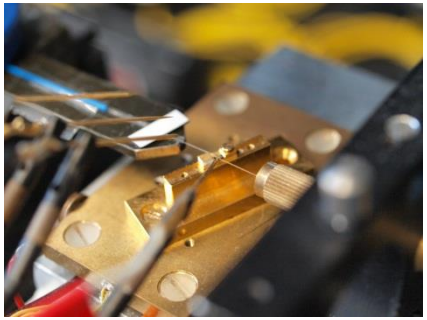
Technische Universität Berlin - expertise

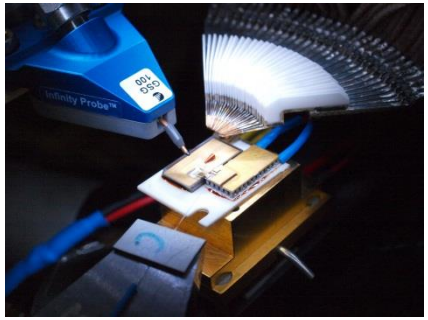
ASPIC characterization

- Packaged passive and active chips
- Electrically submounted active chips
- Unpackaged passive and active chips

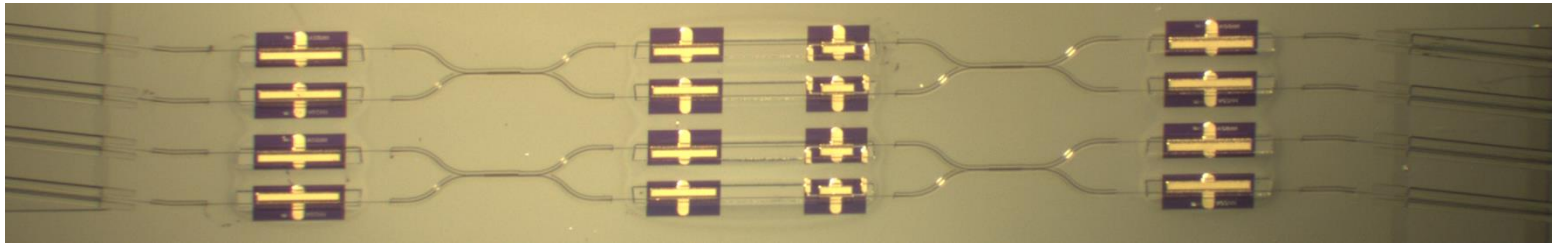


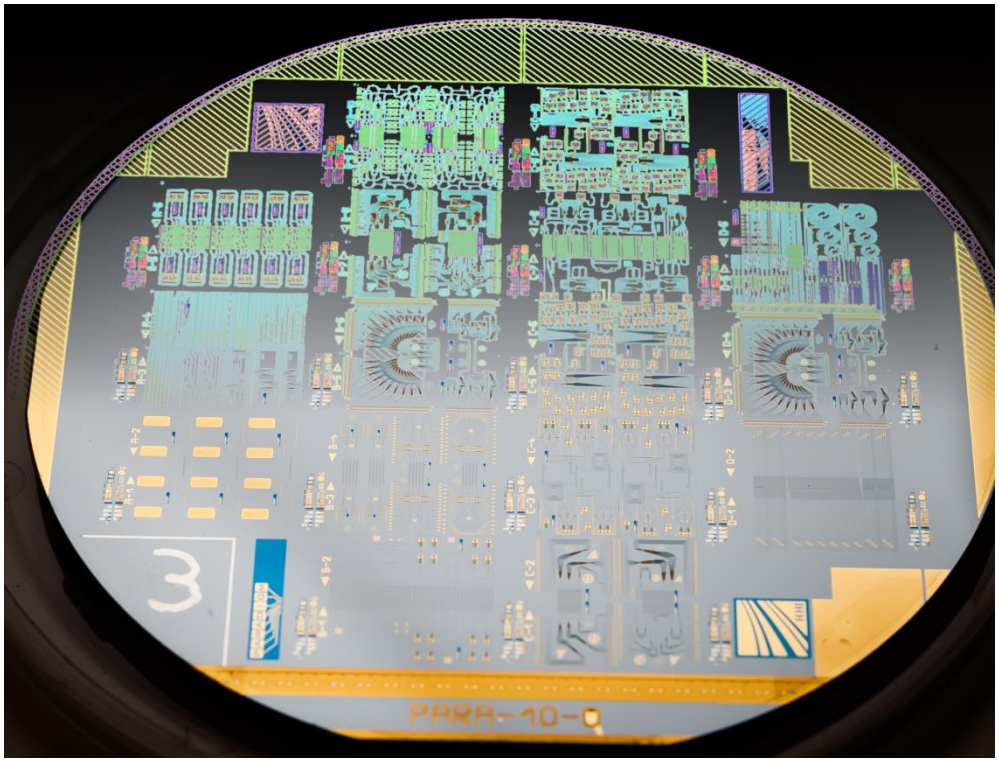
- **Passive devices:** Wavelength- and polarization resolved measurements, fiber-based and free space
- **DC measurements:** LIV curves, EO response, spectral responses, noise figures, linewidths, extinction, farfield
- **RF measurements:** Purely electric, electro-optic, opto-electric, 0-65 GHz
- **System measurements:** 70 Gbit/s NRZ, 32 Gbaud with arbitrary signals, coherent signal generation / detection, BER/EVM analysis, nonlinear predistortion

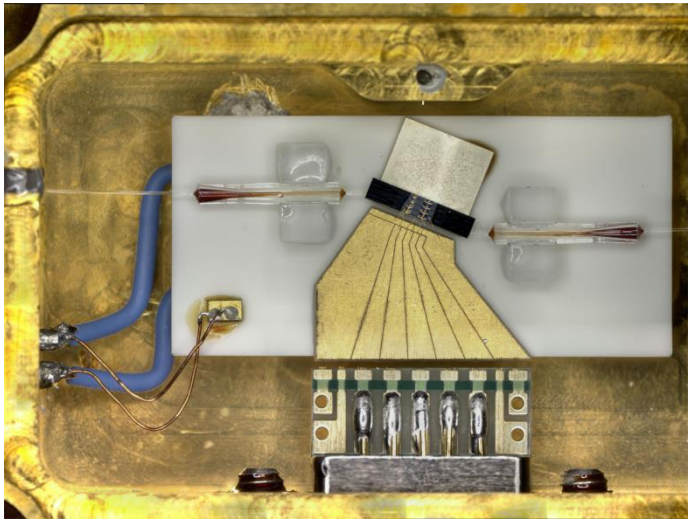




Technische Universität Berlin - expertise







Aarhus University

Aarchus Universitet
Scandinavian Application & Support Center

Contact person
Martijn Heck
mheck@eng.au.dk

Aarhus University - expertise

Experience with all major PIC technologies
indium phosphide, silicon and silicon nitride photonics

Full PIC value chain support
from simulation and design to application-specific chip realization and test

Test & measurement
high-speed (< 30 GHz), low noise characterization of unpackaged PICs (1500 – 1600 nm)

Wide range of applications
telecom, interconnects, microwave and terahertz photonics, Lidar, and accurate metrology

Institut Mines-Telecom

Institut Mines-Telecom

Contact person
Kevin Schires
kevin.schires@telecom-paristech.fr

Institut Mines-Telecom - expertise

Strong Experience in Laser Dynamics
Characterization, extraction of physical parameters, simulation

Test & Measurement
Static and dynamic (up to 40 GHz) characterization of packaged and unpackaged C-band PICs

Recent work
Coherent optical communication, digital signal processing
Study of optical feedback in silicon lasers

Institute of Communication and Computer Systems

Institute of Communication and Computer Systems
National Technical University of Athens
Photonics Communications Research Laboratory

Contact persons:
Paraskevas Bakopoulos, pbakop@mail.ntua.gr
Dimitris Kalavrouziotis, dkalav@mail.ntua.gr

Institute of Communication and Computer Systems - expertise

ASPIC design

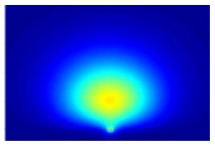
PhoeniX Software
Solutions for Micro and Nano Technologies

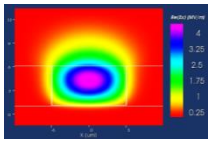
aspic

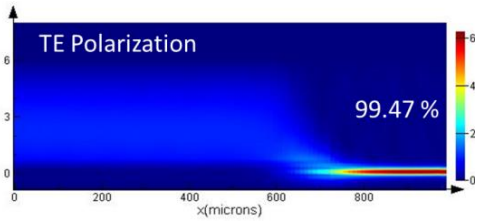
lumerical

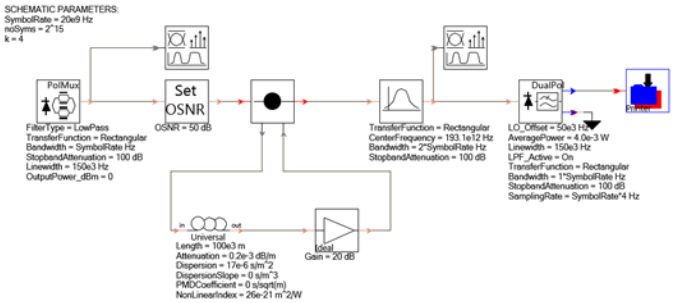
VPIphotonics
DESIGN AUTOMATION

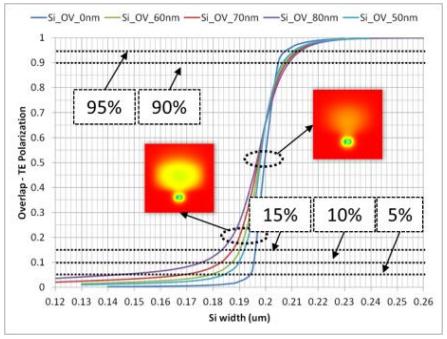
- **Access to photonic CAD software**
  - ✓ *OptoDesigner*
  - ✓ *ASPIC*
  - ✓ *Lumerical*
  - ✓ *VPIphotonics*
- **Experience in design of ASPICs for**
  - ✓ Telecommunications
  - ✓ Datacom/Computercom
  - ✓ Sensing systems
- **Experience in using generic Si and InP platforms**

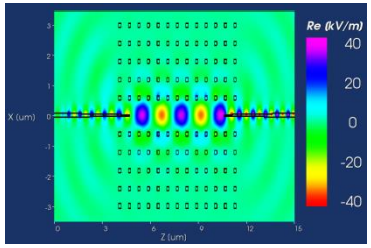


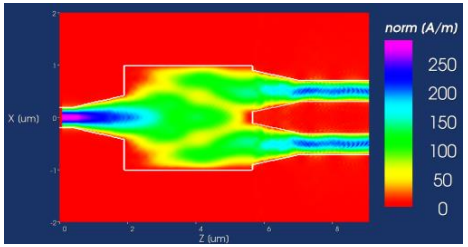










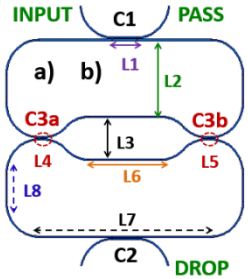


AMO

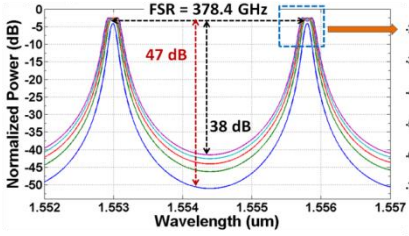
Fraunhofer
Heinrich Hertz Institute

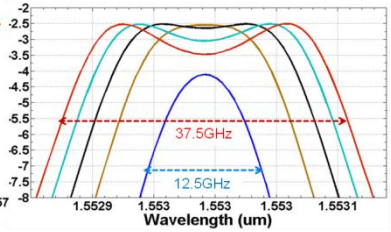
imec

amo



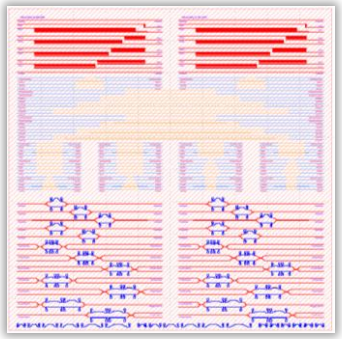
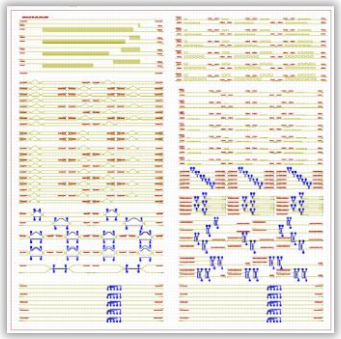
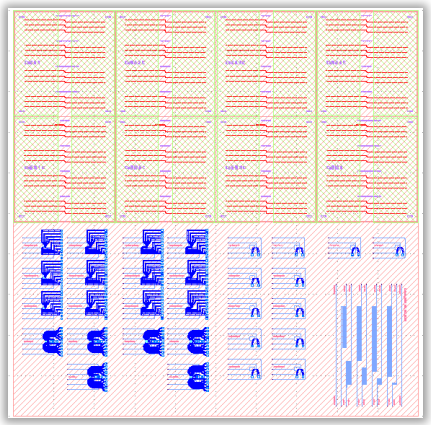
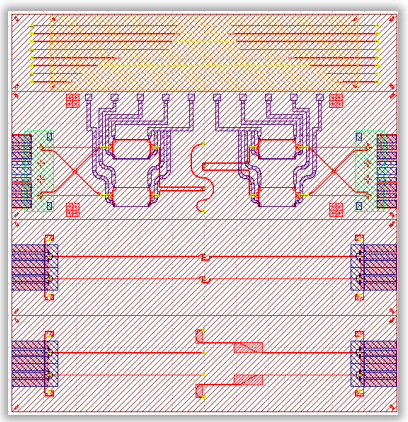
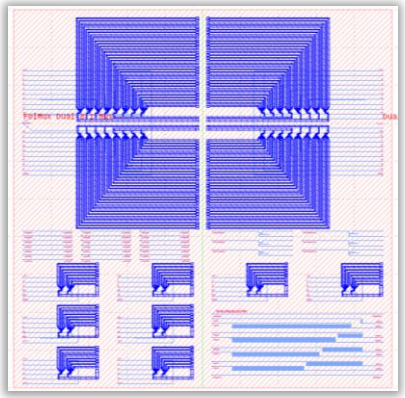
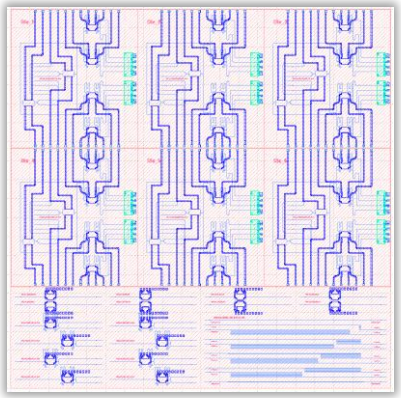
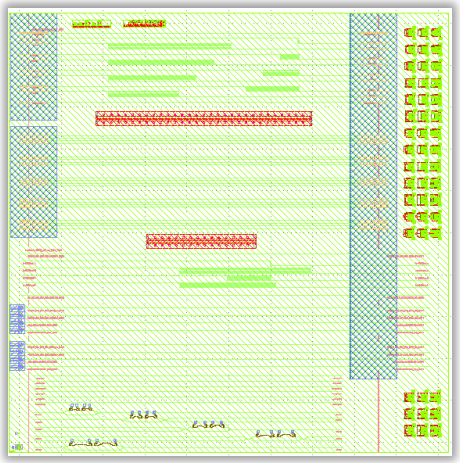
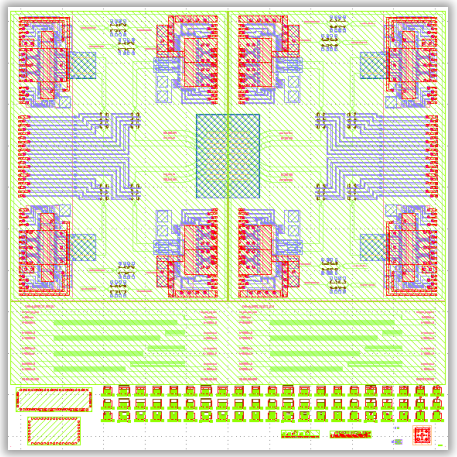
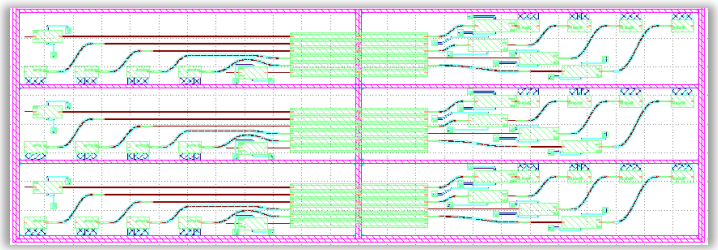
Straight Distances	Length (um)
L1 (C1, C2)	7.8
L2	21.2
L3	11.6
L4 (C3a)	1.6
L5 (C3b)	1.6
L6	22.75
L7	54.25
L8	8





Institute of Communication and Computer Systems - expertise

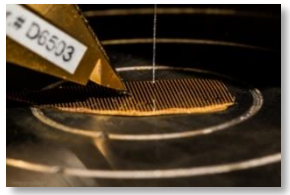
ASPIC Mask layout design

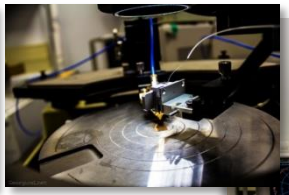










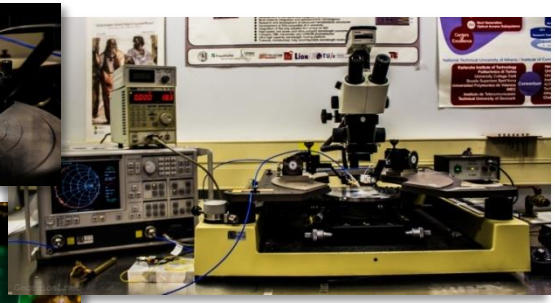
Institute of Communication and Computer Systems - expertise

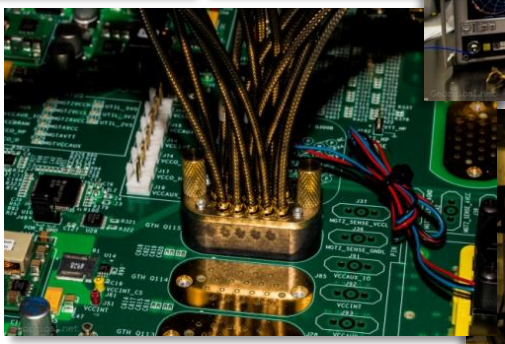
ASPIC characterization

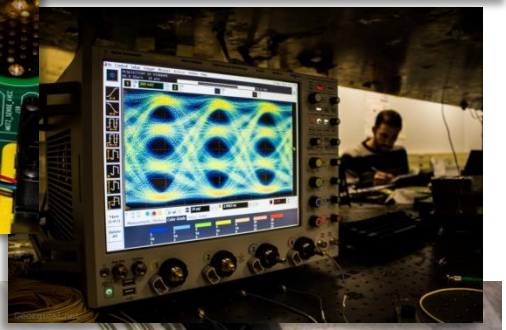
- Packaged passive and active chips
- Unpackaged passive and active chips
- In-plane and out-of-plane coupling











- 40 GHz RF probe station and VNA
- Sources and Generators
  - ✓ 65 Gsa/s arbitrary waveform generator
  - ✓ 56 Gb/s ETDM testbed
  - ✓ 32 Gbaud dual-polarization IQ MZM, 40 Gb/s MZMs and EAMs
  - ✓ narrow linewidth laser sources
- Receiver, scopes and visualizers
  - ✓ 33 GHz, 80 Gsa/s real time oscilloscope
  - ✓ 70 GHz equivalent time oscilloscope
  - ✓ 64 Gbaud coherent receiver
- FPGA boards (Virtex 7, NetFPGA)
- wavelength selective switches, PLZT fast optical switches
- optical transmission recirculating loop

European Photonics Industry Consortium

European Photonics Industry Consortium
www.epic-assoc.com

Contact person
Jose Pozo
jose.pozo@epic-assoc.com

European Photonics Industry Consortium - expertise

EPIC is the industry association that promotes the sustainable development of organisations working in the field of photonics in Europe. EPIC fosters a vibrant photonics ecosystem by maintaining a strong network of **260+ members and acting as a catalyst and facilitator for technological and commercial advancement**. EPIC publishes **market and technology reports, organizes technology workshops and B2B roundtables, coordinates EU funding proposals, advocacy and lobbying, education and training activities, standards and roadmaps, pavilions at exhibitions**.

Our members and activities encompass the entire value chain:

- biophotonics
- displays
- imaging
- lasers (for industrial, military, medical applications)
- LED, OLED, and smart lighting
- optical fibers
- optical components
- photonic integrated circuits: III-V, silicon photonics, TriPleX
- projectors
- PV solar energy including CPV and OPV, and Batteries
- sensors (for automotive, defense and medical applications)
- and all other photonic related technologies

European Photonics Industry Consortium - expertise

EPIC – advocacy

- presence
- rewarding
- sponsoring

EPIC – external communications and publications

- in the media
- sharing event reports
- sharing market and technology reports
- gathering experts and leaders

EPIC – central role in the photonics community

- connecting with industry
- learning from industry
- on stage
- maintaining a global network
- industrial and European networks
- venture and finance working group
- association partners
- business partners
- Day of Photonics

Berenschot

Berenschot

Main office: Utrecht, The Netherlands
www.berenschot.com

Contact person:
John Eisses
j.eisses@berenschot.nl

Berenschot - expertise

- The oldest Dutch management consultancy company in the Netherlands (founded 1938)
- Comprising about 300 employees
- Specialised in a broad range of management issues in both profit and non-profit sector

Department for Strategy, Funding & Innovation

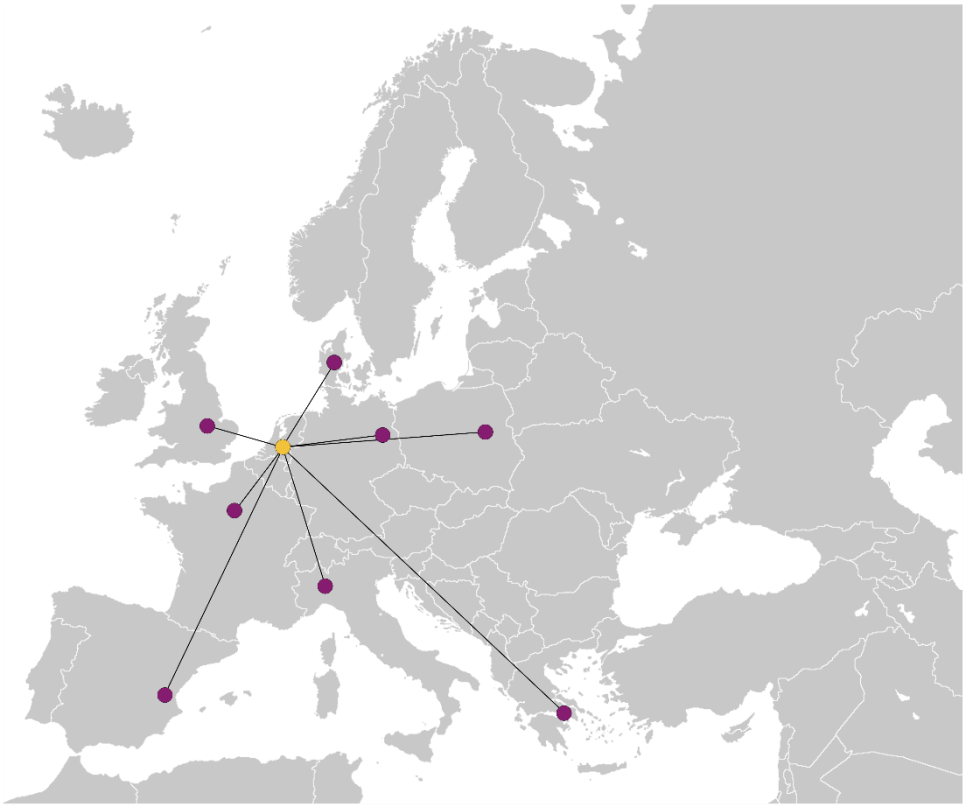
- a.o. (Support in) formation of industrial and industrial-academic cooperation clusters
- Development of technology roadmaps of various sectors
- Generation of technical co-operation projects in a broad range of disciplines
- Applying for (governmental) funding
- Project coordination and project management

Founder Mr. B.W. Berenschot

Coordinator

TU/e Technische Universiteit Eindhoven University of Technology

Partners



UNIVERSITY OF CAMBRIDGE

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

POLITECNICO DI MILANO

Technische Universität Berlin

AARHUS UNIVERSITY

TELECOM ParisTech

National Technical University of Athens

EPIC European Photonics Industry Consortium

Berenschot

http://www.pics4all.jeppix.eu/